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MÁSTER UNIVERSITARIO EN INGENIERÍA INDUSTRIAL

TRABAJO FIN DE MÁSTER

CAPTURE RATE IMPACT IN A PROJECT FINANCE STRUCTURE OF A PHOTOVOLTAIC POWER PLANT

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Madrid

Julio de 2019

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RESUMEN

Durante los últimos años, gran cantidad de empresas están queriendo entrar en el mercado español de las energías renovables. Muchas de estas empresas no tienen gran capacidad de inversión. Por tanto, para hacer realidad sus proyectos recurren a una herramienta de financiación conocida como *project finance*. Dicha herramienta consiste en la financiación de un activo fijo mediante la creación de una empresa independiente financiada con deuda sin recurso. El *project finance* tiene como principal ventaja el hecho de conseguir altos niveles de endeudamiento, por lo que empresas sin gran poder financiero pueden hacer realidad sus proyectos.

Este trabajo fin de máster tiene como objetivo el analizar cómo afecta la variación del factor de apuntamiento en una estructura de *project finance* para la financiación de la construcción de una planta fotovoltaica (FV) en España. Dicho factor representa el precio al que una central vende su energía con respecto al precio medio de mercado. En la actualidad, el factor de apuntamiento de las plantas fotovoltaicas en España está por encima de la unidad, ya que vende su energía en las horas centrales del día, cuando el precio es más alto debido a la alta demanda, así como el mix eléctrico es el que genera costes más altos.

Sin embargo, se espera que durante los próximos años el precio pase a ser más bajo de día, debido a la alta penetración de plantas fotovoltaicas por varios motivos: transición ecológica, idoneidad de España por las altas horas de Sol, incentivos del gobierno para invertir en energía limpia, así como la gran reducción en el precio de los paneles solares. Esta reducción de precio durante el día haría que el factor de apuntamiento pasase a ser inferior a la unidad para plantas fotovoltaicas, lo que podría suponer que la inversión no fuese tan rentable. Además, se habla del término de canibalización de la fotovoltaica, que supone que, si hay una alta penetración de energía fotovoltaica en el mercado eléctrico, algunas de estas centrales no podrían verter su energía a la red, pese a que vendan su energía a coste cero, porque la generación superaría a la demanda.

Por otro lado, otros expertos consideran que el factor de apuntamiento no puede bajar de la unidad para tecnología FV por diversos motivos: el desarrollo de tecnología de almacenamiento permitiría vender la energía solar por la noche; una disminución

drástica en las previsiones del factor de apuntamiento supondría que la inversión dejaría de ser rentable, por lo que no habría tan alta penetración; el Gobierno no permitiría que los precios bajasen de cierto nivel debido a los incentivos para la inversión.

Basado en esta incertidumbre sobre el futuro del factor de apuntamiento, este proyecto tiene como objetivo analizar como dicho factor afecta a la rentabilidad de un proyecto fotovoltaico, mediante un modelo de *project finance*. Para ello se supondrán varios escenarios, desde muy optimistas a muy pesimistas. Una vez obtenidos los resultados se analizarán las variables que definen la rentabilidad, concluyendo si dicha variación del factor de apuntamiento es significativa o no.

Palabras clave

Project finance, energía solar fotovoltaica, factor de apuntamiento, apalancamiento financiero, rentabilidad

ABSTRACT

For the last several years, large number of companies have wanted to enter in the Spanish renewable energy market due to its attractiveness. Lots of these companies do not have strong financial capability. Therefore, to bring their projects to reality they turn to a financing tool known as project finance. This tool consists in the financing of a fixed asset by the creation of a legally independent project company financed with nonrecourse debt. The main advantage of project finance is the fact of getting great levels of financial leverage, so companies without financial strength can bring their project to reality getting debt loans.

The objective of this master's thesis is to analyse how a variation of the capture rate can have in a project finance structure for the financing of the construction of a Spanish photovoltaic (PV) power plant. That capture rate represents the price at which a certain power plant sells its energy in comparison with the average pool price. Currently, that rate is above one for Spanish photovoltaic power plants, as they sell their energy during the central hours of the day, when the pool price is the highest due to the high demand, as well as electrical mix that generates the higher costs.

Nevertheless, it is expected that during the next years the price becomes lower during day hours, due to the high penetration of PV power plants for different reasons: ecological transition, suitability of Spain due to the high number of hours of Sun, Government incentives to invest in clean energy sources, reduction of the cost of solar panels… This reduction of price during the day would make the capture rate become lower than one, what could lead to a situation in which PV power plants would not be that profitable. Furthermore, experts talk about the cannibalization of PV phenomena, that supposes that if there is a high penetration of PV power plants in the energy market, some of these plants would not be able to pour their energy in the system (despite they do it at cost zero), because the generation could overpass the demand.

Conversely, other experts suggest that the capture rate cannot be bellow one for the PV technology due to different reasons: the development of energy storage technology would enable to sell solar energy at night; a drastic reduction of the capture rate forecast will make the investment unprofitable, so the penetration would not be that high; the Government would not allow that prices underpass a certain level due to the incentives for investment.

Based on this uncertainty of the future of the capture rate, this master's thesis has as objective to analyse how this rate affects the profitability of a photovoltaic project, through a project finance model done with Excel. For doing so, several scenarios will be used, from very optimistic to very pessimistic. Once the results are obtained, the variables that define the profitability will be analysed, concluding if the capture rate variation affects a lot or not.

Keywords

Project finance, photovoltaic solar energy, capture rate, financial leverage, profitability

To my parents and siblings,

for trusting me always

ACKNOWLEDGEMENTS

At this point I will like to thank all the people who has help me to achieve what I have achieve during all these years.

The most important people to acknowledge this master's thesis are my parents. Thank you, Rosa and Rafael, for supporting me during the last twenty-four years, not only financially, but on many other aspects that have made me what I am today. And special gratitude also to my siblings, that are full of goodness and excellent advices.

Next person I would like to acknowledge this thesis is Paula. Ever since I met her, she has been supporting me, pushing me forward, and trusting on me in every situation.

Thank you also to Luis Garvía, who has guided me through this thesis, teaching me all his knowledge about project finance, not only in class but also out of it.

Las but not least, I want to thank all the people that have been by my side during these last seven years at Comillas University. Long hours I have spent studying, that without all the friends and colleagues I have met, this would have been impossible. You have made me feel at home, and you would always be in my heart.

Madrid, 2019

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1. Introduction

1.1. Objective

This master's thesis has as main objective to analyse how the variation of the photovoltaic capture rate can have in the financing of a photovoltaic power plant through a project finance structure. This capture rate represents the ratio between the price at which a power plant sells its energy and the average price of the market. There is lot of uncertainty of what will be the future value of this rate for photovoltaic technology. Therefore, using different scenarios for this rate, the financing of a photovoltaic power plant will be studied.

Some secondary objectives will also be pursued:

- Study in detail how the power plant is going to be. For this purpose, the results must contain: the total power, the necessary panels, the hours of Sun, the initial investment needed …

- Explain what the capture rate is exactly and what makes that the future of it so uncertain.

- Make a brief research of the Spanish electricity market, and how the pool prices are regulated.

1.2. Methodology

To achieve the objectives a methodology will be followed:

- In order to analyse how the variation of the capture rate will affect the financing of the project, a complete financial model will be developed with Microsoft's Excel. There will also some macros developed with Visual Basic, a programming language for Microsoft Office programmes.

- A research on the Spanish electricity market will be exposed in order to understand properly the capture rate.

- In order to build the financial model, a research will also be needed in order to have a financial model as close to reality as possible. These variables are for example, the inputs for the model such as the initial investment or the expenses the power plant may have.

1.3. Structure of the project

Now that the objective and methodology is clear, it is time to explain how the project will be structured.

First, there will be a bit of research through a state-of-the-art section. In this section, there will be a recompilation of what have been done regarding project finance and capture rate.

Next section will be to describe how the power plant is it going to be. Lots of variables must be considered such as location or the manufacturer of the solar panels.

Then, the capture rate will occupy the next section. For it, there will be a background part, explaining the Spanish electricity market, and then the relation of it with the capture rate. Lastly, the different scenarios chosen for doing the sensitivity analysis will be exposed.

Afterwards there will be two sections dedicated to the financial model. First one will be to expose the inputs and outputs of the model. Second one, will be the results of the sensitivity analysis run with the different capture rate scenarios.

This thesis will be finished with a conclusions section in order to expose if the objectives have been achieved.

1.4. Problem description

Medium and small size construction and development companies find always difficult to get the necessary money to bring their projects to reality. Most of the times what this companies do is creating a legally independent project company a finance it with non-recourse debt. This is what is called project finance, and in most cases the leverage achieved is very high, this is, that a high percentage of the investment needed is financed by the banks.

However, for getting this high leverage, all the projections in the financial model should be very clear. One of the projections needed is the price of the electricity market over the operating life of the project. Many energy consulting firms give this projection, but as an average of the daily selling price of the electricity. However, in the electricity market, the selling price varies depending on the time of the day in which that energy is produced. So, here appear a new projection called the capture rate, that quantifies if that specific energy is going to be produced when the electricity is sold more expensive or cheaper.

Up to now, the capture rate value for photovoltaic power plants was always above 1, as the energy is now more expensive during daytime (while the photovoltaic energy is produced). However, now there is discrepancy with this capture rate. This is because, the renewable energy is growing fast, and being Spain a country with lots of hours of Sun, the photovoltaic technology is growing faster. Therefore, some people think that there is going to be that much offer than the photovoltaic market is going to be so competitive that they will be the cheapest ones selling energy. If this happen, the capture rate will reduce drastically. Other things, that if this happen, nobody will be willing to invest, so the capture rate will remain above one.

Therefore, the problem that is going to be solved in this thesis is how this capture rate can impact the financing of a PV power plant. Locating the photovoltaic power plant in Albacete, a complete project finance model is going to be done, analysing how the capture rate can impact the leverage, and the level of how companies are affected by this rate in order to finance their photovoltaic projects.

2. State of the art

Benjamin C. Esty described Project Finance as the financing of a fixed asset by the creation of a legally independent project company financed with nonrecourse debt (Esty, 2004).

In the past, when a company wanted to develop a big project and did not have money for it, this company will borrow a loan from a financial entity (Esty, 2003). For this to happen. The company had to be a big corporation in order to get the money. However, with project finance small companies with no financial rating can sponsor their project with the creation of the project company, also called Special Purpose Vehicle (SPV), by borrowing the loan not for the corporation, but for the SPV. Project finance also allows the SPV to have a leverage ratio higher than 50% which makes the project profitable and attractive for investors (Garvía, 2008b).

In other words, project finance is financing a project using not extra guarantees apart from the project itself (the future cash-flows that will generate) (Garvía, 2008a).

In order to do a proper project finance analysis, it is very important to calculate accurately the revenues and costs that the project will generate during the operating life. This is in order to do the debt sizing; hence the money banks and funds are going to invest in the project company. If the cash flows are not forecasted precisely, the project could lose the capacity to repay the debt and enter default.

Project finance is used to finance project from diverse types. It is used in infrastructure projects (Dalami & Leipziger, 1998), in renewable energy plants (Steffen, 2017).

This Thesis will be focused in renewable energy projects. Project finance is very important in these kinds of projects. To fight climate change, renewable energy is necessary, so the investment needed is huge. In order to make investors and banks attracted by these projects, project finance is an effective method due to the profitability obtained (Steffen, 2017).

In such projects, it is very important to consider the capture rate. The capture rate indicates the ratio between the revenues obtained supposing the electricity prices are variable, and those revenues obtained if the prices were fixed (Jiménez, Puche & Triviño, 2018b). Electricity prices vary during the day, being higher during the day hours, when the demand is higher, and lower during the night times due to low demand. If the capture rate was not considered in a project finance analysis the forecasted revenues per energy produced will be the same in a photovoltaic plant and in a wind farm. However, as photovoltaic plants produce electricity during the day, they perceived a higher price than the average of the day, so the capture rate is higher than 1. On the contrary, wind farms produce the electricity during night hours, being its capture rate below 1 (Jiménez, Puche & Triviño, 2018a).

However, things are expected to change, especially in Spain, where Sun is one of its best resources. It is expected that a great number of photovoltaic megawatts will be installed in the next years. This will produce a huge competence between solar energy producers, which will make that electricity will be cheaper during the day. This is called the *cannibalization of the photovoltaic* and one of its consequences is that the capture rate could go from being higher than 1 to lower the one (Altran, 2018).

Therefore, this Thesis will analyse how this possible change of the capture rate could affect the financing of a photovoltaic power plant using project finance.

3. Characteristics of the photovoltaic power plant

This epigraph is to describe the general characteristics of the power plant, as well as the location of it.

3.1. Location of the power plant

The photovoltaic power plant is going to be in the Spanish province of Albacete. This province is part of the autonomous community of Castilla-La Mancha, located in the middle south of Spain.

Figure 1. Location of Albacete province in Spain

The reasons to choose this location are two: the first one is because my family owns a property in this province, to the east of the capital city of it, also called Albacete; and the second one is because this location offers a perfect spot for photovoltaic technology due to the hours of Sun and the quality of it (this will be explained in detail afterwards).

The property my family owns, called *La Choza*, has a total surface of 330 hectares. Furthermore, there is already an existent photovoltaic power plant in the property, which is also called *La Choza*, managed by the Spanish electricity company T-Solar and the characteristics of it are presented hereunder (T-Solar Projects, n.d.):

- Year of construction: 2008
- Coordinates: 38°59'03.5"N 1°58'47.4"W
- Extension: 8,2 hectares
- Power: 2,05 MWp
- Number of installed panels: 12.672
- Produced energy per year: 3.331.699 kWh
- Power consumption of households: 764
- CO_2 emissions avoided: 1.193 tonnes/year

Source: GoogleMaps

Figure 2. Location of La Choza property with respect to Albacete city

Source: GoogleMaps

Figure 3. Location of La Choza photovoltaic power plant with respect to La Choza property

As it can be inferred from the information above the net equivalent hours of Sun energy in *La Choza* power plant are 1.625 hours and the ratio between extension and power is around 4 hectares per 1 MWp. However, during these last 11 years, photovoltaic technology has been developed broadly, and the improvements are going to be exposed in the details of the plant which are the purpose of this master's thesis. This is part of the epigraph 3.2.

The new photovoltaic power plant it is supposed to be located just next to *La Choza*, as shown in the Figure 4 and it will occupy an extension of 16 hectares.

3.2. Properties of the photovoltaic power plant

Now the location is chosen is time to specify the characteristics of the power plant. As appointed before, the extension of it is going to be 16 hectares, which allows to build a photovoltaic power plant of 8 MWp. This is the first improvement presented of the PV technology during the last years. Whereas in 2008 the ratio of hectares by megawatt was 4:1, nowadays this ratio is 2:1 (Narashiman, 2014). An additional advantage to achieve this ratio is that Albacete presents a very flat soil, so the Sun impacts the panels the whole day. To choose the exact area, a simple software programme has been used, that calculates the area, introducing some points (CalcMaps, n.d.).

Source: CalcMaps, n.d.

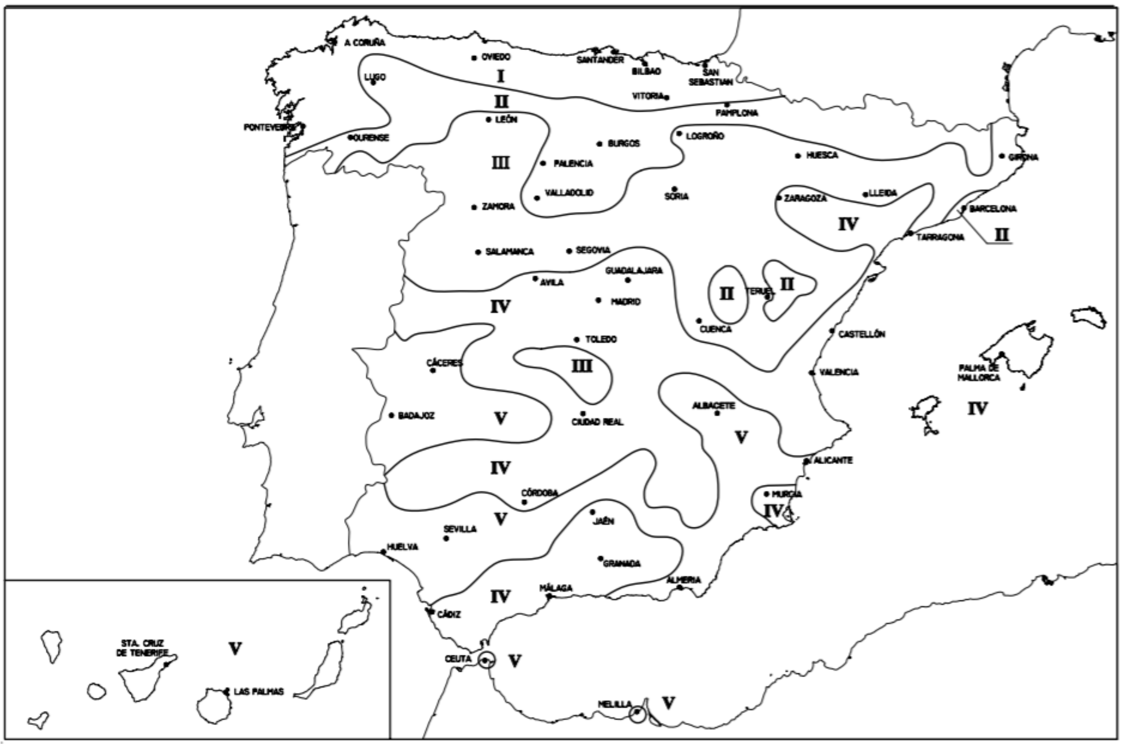
Figure 4. Location of the new photovoltaic power plant of 16 hectares

Next step is to define the net equivalent hours of Sun per year. For this matter, it is important to give a brief explanation of the Spanish solar background. The Spanish Technical Edification Code (CTE) divides Spain in five climate zones, considering the annual Global solar radiation on a horizontal surface (H). The limits between climate zones are presented in the Table 1.

Table 1. Annual Global solar radiation on a horizontal surface

Climate Zone	MJ/m^2	kWh/m^2
I	H < 13,7	H < 3,8
II	13,7 ≤ H ≤ 15,1	3,8 ≤ H ≤ 4,2
III	15,1 ≤ H ≤ 16,6	4,2 ≤ H ≤ 4,6
IV	16,6 ≤ H ≤ 18,0	4,6 ≤ H ≤ 5,0
V	H ≥ 18,0	H ≥ 5,0

Source: CTE, n.d.

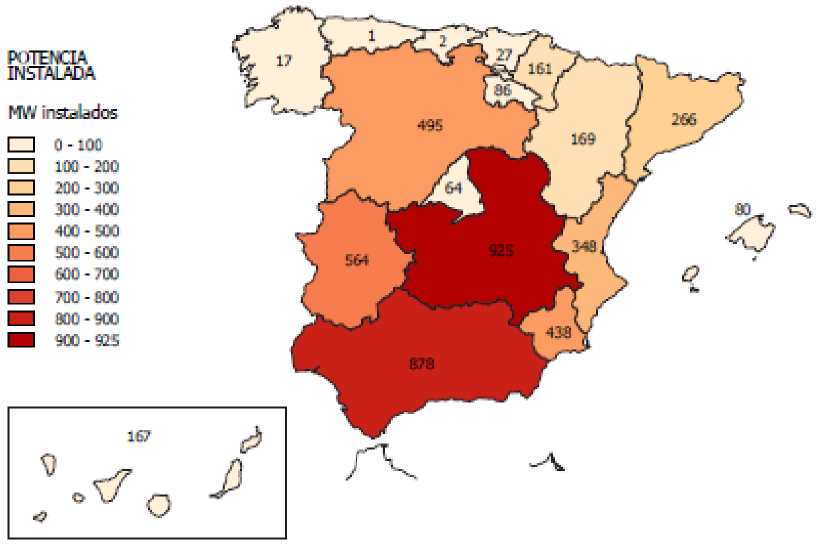


Source: CTE, n.d.

Figure 5. Solar zones in Spain

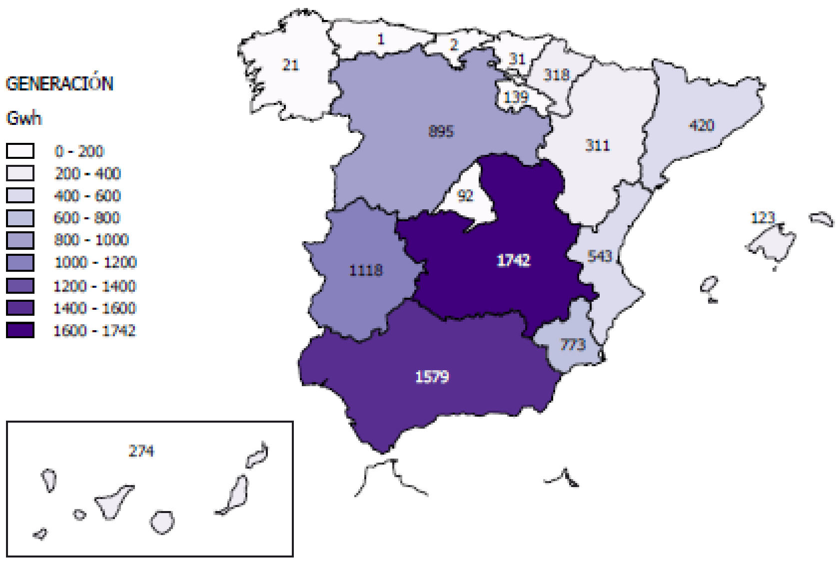
Therefore, as it can be seen in the map above, Albacete is an ideal zone for generating electricity with the Sun, as it is in the climate zone V, which has the highest Radiation in the Spanish territory. Based on the Spanish Technical Edification Code (CTE) previously mentioned, it provides the net equivalent hours of Sun for photovoltaic purposes, depending on how many axes does the solar tracker of the panels have, one or two. This means, that the panels can rotate in one or two directions with the Sun. For this thesis, the panels considered are going to be of single – axis tracker ones, being the net equivalent hours of Sun per year of 2.279 hours (Zonas Solares, n.d.). This leads to a total energy produced of 18.232.000 kWh per year.

Regarding the location, it is also important to remark that the autonomous community of Castilla-La Mancha has the highest installed capacity of photovoltaic solar energy in Spain and it generates the highest amount of energy through this technology. This says a lot about this region



Source: UNEF, 2018

Figure 6. Photovoltaic installed capacity in Spain by autonomous community



Source: UNEF, 2018

Figure 7. Electricity generated with photovoltaic energy in Spain by autonomous community

Now is time to decide which elements will be used to build the power plant. The tracker chosen is the SF7 Single – Axis Tracker, manufactured by the Spanish company Soltec (Soltec, n.d.).

Next issue to consider is the number of panels needed to be installed. In the old photovoltaic power plant of La Choza the power of each panel was of approximately 162 Wp per panel. This is another factor that has improved over the last years. Nowadays, solar panels have around 300 Wp each. This means that for the photovoltaic power plant considered, the number of panels required is 26.667 panels. The solar panels chosen are going to be the model Eagle PERC 60 300 Watt manufactured by the Chinese company Jinko Solar (JinkoSolar, 2017).

Next step to consider is the CO_2 emissions avoided. For doing so, the International Renewable Energy Agency (IRENA) considers that the total amount of coal emissions avoided by PV technology is of 375,34 tonnes of CO_2 per year per GWh produced. Therefore, as the plant will generate 18,232 GWh per year, the emissions avoided are going to be of 6.842,46 tonnes per year.

Lastly, it is necessary to determine the electrical substation through which the electricity generated will be input in the electrical network. The closest substation is the Subestación Eléctrica Transformadora (SET) de las Santanas, located in Santa Ana, a municipality located in southwest of Albecete city. This SET is property of the Spanish company Iberdrola and has a total power of 15 MVA (Iberdrola, 2010).

Source: Google Maps

Figure 8. Distance between the new power plant and Santanas substation

As can be seen in Figure 8, the distance between the new PV power plant to be constructed and Santanas substation is 5,26 km. This distance is needed in order to calculate the electric line that needs to be constructed and must be considered as part of the investment for the project finance model.

Last, it is important to talk about schedule. It will be supposed that the power plant will be constructed during 2020 and will start the operation in January

2021. The operation life of the powerplant will be fixed in 30 years, therefore, the operation will finish in 2050.

To sum up, the characteristics of the photovoltaic power plant that is going to be considered for the project finance structure that is the main topic for this master's thesis are:

- Year of construction: 2020
- Start of the operation: January 2021
- Operation period: 30 years (up to 2050)
- Coordinates: 38°59'03.5"N 1°58'47.4"W
- Extension: 16 hectares
- Power: 8 MWp
- Net equivalent hours of Sun: 2.279 hours
- Number of installed panels: 26.667 panels
- Panel model: Eagle PERC 60 300 Watt by Jinko Solar
- Tracker model: SF7 Single – Axis Tracker by Soltec
- Produced energy per year: 18.232.000 kWh
- Electrical Substation (distance to it): Santanas (5,26 km)
- Power consumption of households: 4.000
- CO2 emissions avoided: 6.842,46 tonnes/year

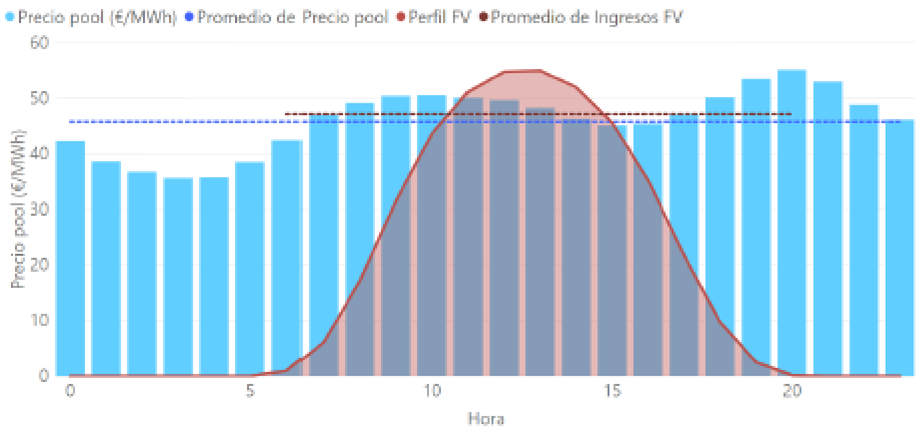
4. Capture rate

4.1. Definition of capture rate

The capture rate is the ratio between the real price charged by a power plant and the average pool price of the electricity market (Altran, 2018). In the case of power plants of technologies that are working the whole day (such as nuclear power plants), its capture rate is one as the selling price is the same than the day average.

However, there are other power plants of other technology that only work certain times of the day, such as wind power plants or photovoltaic power plants. In these cases, the capture rate will be different to one, as it only captures certain prices of the day.

For this master's thesis, the purpose is to analyse the impact of capture rate in project finance structures of photovoltaic power plants. Historically, the pool price has been higher during daytime hours. Therefore, photovoltaic power plants have achieved a higher price that the average pool price. This means that the capture rate of photovoltaic power plants is higher than one, as it gets a higher price than the average of the day.



Source: Altran, 2018

Figure 9. Hourly average pool price (2007-2017) and hourly average generation profile of PV technology

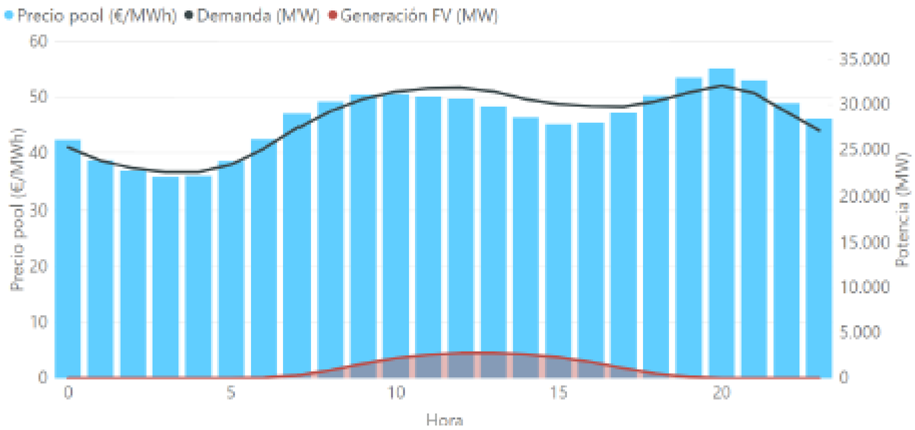
Currently, capture rate for PV technology in Spain is around 104 %, which means that for each MWh sold, this technology gets 1,04 times the average price of the pool. However, some experts expect this to change, due to the high amount of new photovoltaic power plants that are going to be part of the system.

4.2. Spanish electricity market

The pool price variation depends mainly on two factors:

- The profile of electric demand. This is, the higher the demand, the higher the price and vice versa.
- The composition of the electric mix. This is the type of technology that is producing the electricity at every moment.

The variation of the pool price with the demand can be easily seen in Figure 10.



Source: Altran, 2018

Figure 10. Relation between pool price and electricity demand

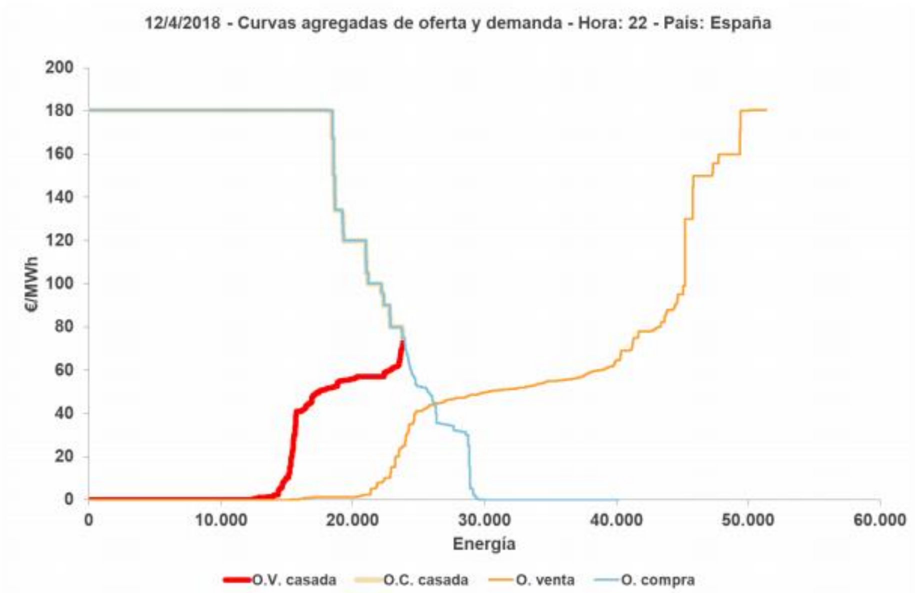
The relation between the pool price and the electric mix have a big relation on how the Spanish electricity market work.

The Spanish electricity market is a marginalist type of market. For explaining the reason of it, it is important to explain how the Spanish electricity market works. There are several markets, but the principal one is the daily market, that regulates the price of every hour for the next day, as well as who will generate and buy the electricity. These markets are regulated by the

Operador del Mercado Ibérico de Energía (OMIE). So, the daily market works as follows:

- Everyday each generator of electricity offers a certain amount of electricity at a certain price that they are willing to sell the electricity in €/MWh. The ones that offer the cheapest electricity are the first that will enter in the market the next day.
- The same happens with demand. Each distribution company demands a certain amount of electricity at a certain price that they are willing to buy it in €/MWh. The ones that are willing to pay the most will be the first to receive the electricity demanded. The maximum price possible is of 180,3 €/MWh. This is the reason why higher the demand, higher the price. When the demand is higher, distributors will be willing to pay more.
- When the price of generation and demand match, this will be the price of the market. This means, that every generator will get the same price and every consumer will pay that same price.

This is the reason why the Spanish electricity market is a marginalist one, because the price offered is based on the marginal cost of the producer (variable cost or cost of producing an extra unit).



Source: OMIE, 2018a

As can be seen in Figure 11, the price for 10 pm of April 12th, 2018 was of around 70 €/MWh and the total amount of energy produced of around 25.000 MWh.

As it can be seen a great part of the energy produced, was offered at 0 €/MWh. This is offered by both, nuclear power plants and renewable energy plants.

Nuclear power plants offer energy at 0 € for two reasons. First, the nuclear fuel is cheap in comparison with the amount of energy produced. Secondly, the costs of disconnecting a nuclear power plant are so high, that they are always in the energy mix.

Renewable energy power plants offer their energy at 0 € due to the marginal cost. The cost of producing the electricity is 0 €, as the source of fuel are the natural resources such as wind or the Sun. Therefore, when these natural resources are available, they will always be in the mix, as they are the cheapest sources of energy.

This is the reason why the electrical mix affect the prices. The higher the amount of technologies with marginal cost 0 producing electricity, the lower the price will be.

Furthermore, PV technology captures the higher price of the pool because it generates the electricity during central hours, when the demand is higher (hence, the pool price higher). During the period 2014 – August 2018, the average pool price has been of 47,19 €/MWh, whereas the average price received by PV power plants of 49,06 €/MWh (Altran, 2018). Therefore:

$$Current\ PV\ Capture\ Rate = \frac{49{,}06}{47{,}19} = 104\% \quad (1)$$

4.2. Importance of the capture rate

The capture rate defines the real amount of money that a certain power plant receives for the energy sold in the market. Therefore, it is of great of importance for doing project finance. When doing a project finance structure of a certain project, the amount of money the bank could lend (debt) is based on the cash flows the project will generate. Therefore, a good estimation of the capture rate is necessary as a variation could lead to a totally different situation, changing the profitability of the project. The objective of this master's thesis is to analyse how these changes affect the project finance structure. But before doing so it is important to explain why there is such an uncertainty of the future value of this rate.

4.3. Capture rate variation

Now that has been explained how the pool price is determined and why currently the capture rate for PV technology is above 1, now is time to explain what factors can suppose a change of the capture rate for PV in the future.

4.3.1. Factors driving a reduction of the capture rate

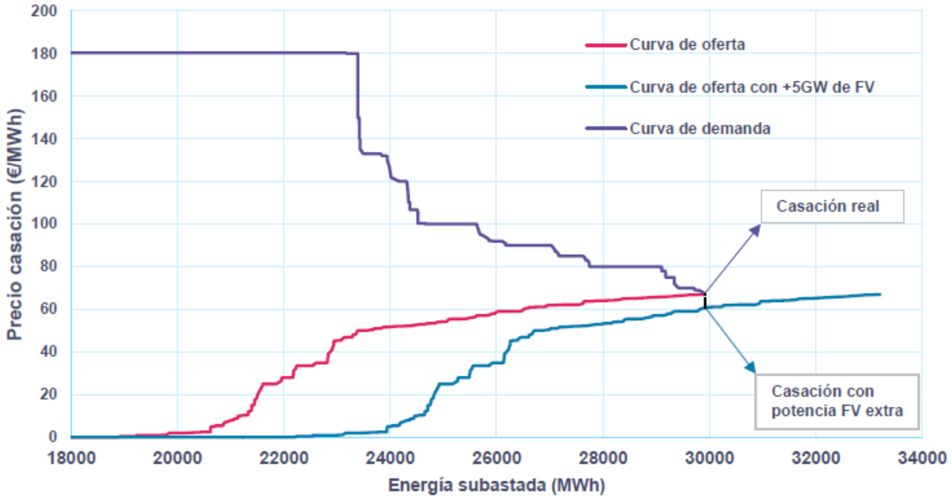
The principal factor driving a decrease of the capture rate according to the experts is the cannibalization of the photovoltaic power plants.

In 2018, the electric consumption in Spain was of 268.808 GWh and the installed capacity of 103.884 MW. Of that capacity, around 30 % is renewable (photovoltaic + wind + thermosolar), and in 2018, the energy produced by these renewable sources was of 23,6 % (REE, 2019).

However, the objectives go beyond this limit. The objectives of the European Union are to generate at least 27 % of the electricity with renewable energy sources by 2030. For that reason

The current photovoltaic Spanish power plants suppose a 4,5 % of the total installed capacity, producing around 2,9 % of the total demand. However, it is expected that during the next years, the investment in photovoltaic power plants could increase drastically due to the fact that the cost of the solar panels is being reduced and the high number of hours of Sun of Spain.

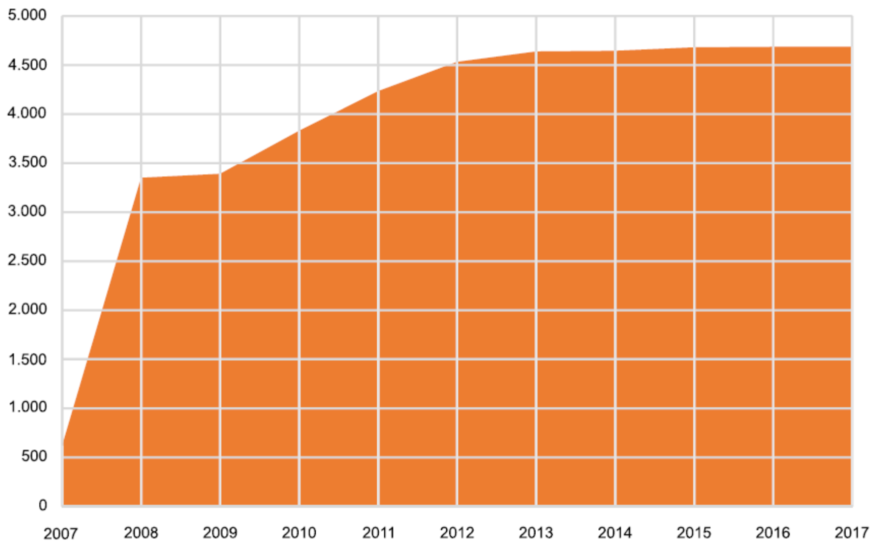
Therefore, supposing nothing else will change except for a high penetration of PV power plants, the pool price during Sun hours will be reduced (as a higher portion of the generation will offer their energy at 0 €/MWh), while during the hours without Sun, the price will remain equal. This will make a lower pool price during the hours of highest demand, making the capture rate of PV bellow one. This effect is known as the cannibalization of the PV. The reduction of pool price during daytime due to the cannibalization of the PV can be seen in Figure 13.



Source: Altran, 2018

Figure 13. Effect on the capture rate of installing extra PV

This high penetration of renewables is highly probable to occur. Currently there are almost 5 GW of PV installed capacity in Spain as can be seen in Figure 14.



Source: UNEF, 2018

Figure 14. Evolution of PV installed capacity in Spain (in MW)

However, during 2019 this quantity is expected to grow around 4 GW, what will mean that it will almost double the presence of PV in Spain. This is due the public auction celebrated in 2017, in which 3,9 GW were granted to PV companies. The powerplants will have subsidies, with the condition of having the plants generating energy on January 2020 (Cinco Días, 2017). Therefore, if nothing else changes in the electricity market, it is true that the PV capture rate may suffer a big decrease.

A study done by the company Altran called *El factor de apuntamiento y el efecto de canibalización en la fotovoltaica. Una perspectiva de futuro* suggests that the installation of 15 extra GW of PV could suppose a capture rate of 42,7 % for PV (Altran, 2018). The same study suggests that the installation of 10 GW of PV will turn the capture rate to 64,1 %, and of 5 GW to 86,9 %.

4.3.2. Factors driving a non-reduction of the capture rate

The factors that could remain the capture rate above one are:

- The decarbonisation of the system and the increase of electric vehicles would lead to an increase of the demand, that would suppose an increase of the pool price.
- The development of energy storage technology would allow PV powerplants to sell energy during the night, so they could be selling energy the 24 hours, leading to a capture rate of around 100 %.
- If capture forecasts are so pessimistic as some experts think, investor will not be willing to invest in this technology due to its low profitability. This is kind of a vicious cycle, as:
    - Based on an expected cannibalization of PV technology, experts expect that the capture rate will be reduced drastically.
    - Investors are not willing to invest in projects of low profitability due to low capture rates forecasts.
    - Therefore, capture rates forecast become optimistic, that make investors attracted by the market.
    - This brings again the cannibalization of the PV, what makes the circle starts again.

- Governments are giving incentives to invest in the renewable energy market to fight climate change. These incentives are giving through subsidies and public auctions. Therefore, they will not allow a situation in which the pool price/capture rate undertake a certain value that do not recover the investment made.

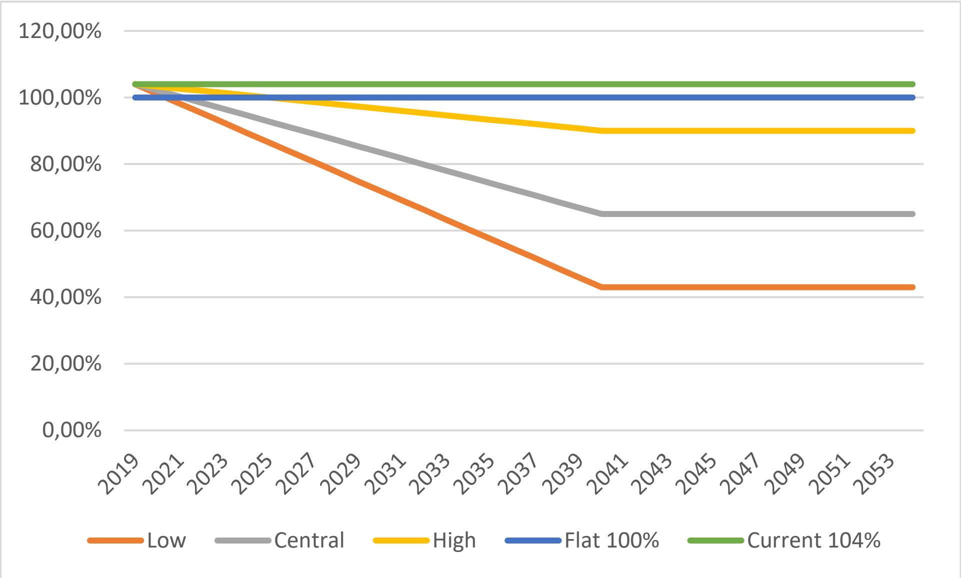
4.4. Capture rate forecast

Based on the explanations of the last section, it is very difficult to know how the capture rate will be in the future. What is certain is that the future of this rate is a big question that can affect the investment in PV technology.

Therefore, for this master's thesis five scenarios are going to be considered in order to further analyse the effects of the variation. Three of them represent a reduction of the capture rate, from very pessimistic to relatively optimistic, and the other two represent the most optimistic forecasts:

- Low: based on the analysis made by the company Altran, a scenario of 15 GW extra of PV with everything else remaining equal, would make the capture rate of 43 %. It is supposed, the rate is reduced linearly until reaching 43 % in 2040.
- Central: based on the same analysis, the installation of 10 GW, will suppose in a capture rate of 65 %.
- High: last scenario of the analysis suggest that the installation of 5 GW will suppose a capture rate of 90 %.
- Flat 100%: in the case of a great development of storage technology, PV power plants would be able to sell their energy the whole day, so they would not be affected by the capture rate.
- Current 104 %: as explained in Section 4.1., the current PV capture rate is at 104 %. Despite, being improbable that it remains at this value, some investors still do their forecasts with this number.

In the Figure 15, all the scenarios are represented in a graph so they can be seen graphically.



Source: Compilation based on Altran, 2018

Figure 15. Capture rate forecast's scenarios

5. Model

After doing some research about what project finance is and the possible changes of the capture rate in the future, it is time to move to describe the model done.

This epigraph will be divided in four parts. First part will be a general description of the model used for the photovoltaic power plant and what are the main outputs this model provides. Next part, will be a detailed description of the inputs introduced in the model, being the third part the same description for the outputs of the model. Last part will be an analysis of the results obtained, focused on what is most relevant for the purpose of this thesis.

5.1. Debt sizing calculation

The model used for this project is a project finance type one, in which the main objective is to calculate the leverage the project can provide. This means, calculating how much money out of the initial investment can be financed by a financial institution (such as a bank) through non-recourse debt. In this section, all the explanations will be theoretical of what the model does, without considering any numerical result. All the numbers used in this model are described in the section 3.2.

Therefore, the calculations done by the model in order to obtain the results are explained hereafter.

The first step is to calculate the revenues the photovoltaic power plant will generate during the operational life of the project. For doing so, the first step will be to calculate the yearly production of the power plant, that is the total power in megawatts multiplied by the equivalent number of hours of Sun during the year. So, for year *n*, the production is:

$$Production_n[MWh] = Power[MW] * NHHE_n \quad (2)$$

Once the production is calculated, the yearly revenues are calculated multiplying this production by the estimated pool price of the respective year and the estimated capture rate of that same year.

$$Revenues\ _n[€] = Production\ _n[MWh] * Pool\ Price_n \left[\frac{€}{MWh}\right] * Capture\ Rate_n\ [\%] \tag{3}$$

In this formula to calculate the revenues is the only formula in which the capture rate will appear. Therefore, the change of the yearly revenues due to changes of the capture rate is what will help to get conclusions on how big the impact is.

Next step is to calculate the earnings before interests, taxes, depreciation and amortization (EBITDA). This is the difference between revenues and costs. In energy projects, the costs are called operation and maintenance costs (O & M), that are all the costs incurred for the correct performance of the power plant. Further detail on what forms the O & M costs will be described in the next section.

$$EBITDA\ _n[€] = \ Revenues\ _n[€] - O\ \&\ M_n[€] \tag{4}$$

The next concept that needs to be calculated is the cash flow available for debt-service (CFADS). Before doing so, it is important to explain what the debt-service is. Debt-service is a concept related to loans and is the amount of money required over a period of time to repay debts (Murray, 2019). So, it is basically the total amount of money paid every year. Every year there must be a repayment of the debt lend by the banks plus the interests:

$$Debt\ Service_n[€]\ = Principal\ Payment_n\ [€] + Interest\ Patment_n\ [€] \tag{5}$$

So, before calculating the debt service the CFADS is what needs to be calculated.

$$CFADS_n = EBITDA_n - Taxes_n - Increase\ in\ WC_n \tag{6}$$

Being the taxes, 20 % of the EBITDA (Earnings Before Interests, Taxes, Depreciation and Amortization), and the increase in WC (Working Capital), the difference of WC between one period and the period before.

Now is time to calculate the yearly debt-service. It is calculated dividing the CFADS by the debt-service coverage ratio (DSCR). DSCR is a measurement of the cash flow available to pay current debt obligations (Hayes, 2019). In a

$$Debt\_Service\ _n[€] = \frac{CFADS_n}{DSCR} \tag{7}$$

project finance structure, the value of this ratios is imposed by the lender (the bank), and its value will be exposed in the section 3.2. Therefore, the yearly debt-service is:

All the financial concepts needed in order to calculate the leverage have already being explained. Now it is time to calculate how much of the debt-service is the principal debt the bank has lend and how much are interests that need to be paid.

The interest’s payment of year *n* is calculated multiplying the interest rate by the outstanding debt (the remaining principal debt that has not been paid yet) of year *n-1*.

$$Interest\ Payment\ _n[€] = Interest\ rate[\%] * Outstanding\ Debt_{n-1} \tag{8}$$

And the principal payment in year *n* is the debt-service of year n minus the interests in year *n.*

$$Principal\ Payment_n[€] = \ Debt\_Service_n[€] - Interest\ Payment_n \tag{9}$$

Lastly, the outstanding debt in a certain year is the outstanding debt of the year before minus the principal paid during that year.

$$Outstanding\ Debt\ _n[€] = \ Outstanding\ Debt_{n-1}[€] - Principal\ Payment_n[€] \tag{10}$$

As it can be seen in the three formulas above, there is a circular reference, as the interest payment of a certain period 'n' is dependent on the outstanding debt of the previous period 'n-1', and the outstanding debt of that period 'n', depend on the outstanding debt of period 'n-1'. This reference leads to a closed loop. Therefore, to break the loop, it is necessary a macro that will be further explained.

Another problem comes when calculating the outstanding debt at the beginning of the project (outstanding debt $_0$). For calculating so, it is necessary to turn to Visual Basic, a programming language made for Microsoft Office programmes (for Excel in this case). With this language, a macro can be done, and using the function GoalSeek we can get the desired result.

The function GoalSeek achieves a desired value in a certain cell, changing the value of another cell. In this case, what needs to be zero is the difference between the outstanding debt at the origin of the project and the sum of all the principal payments, and the value that should change is the outstanding debt at the origin. Being N the number of years of operation:

$$Objective = Outstanding\ Debt_0 - \sum_{n=1}^{n=N} Principal\ Payment_n = 0 \qquad (11)$$

So, the function GoalSeek would turn the objective cell to zero, changing the value of the cell (outstanding debt $_0$). Henceforth, the process to follow is to give a random value to the cell (outstanding debt $_0$). Then, the interest payments, the principal ones and the outstanding debt are calculated for every year with the formulas (8), (9) and (10). So, after doing the sum of all the principal payments, the function GoalSeek would be applied.

All the process described above is not done manually, but automatically with the help of a macro called Circular, as it breaks the circular reference already explained. The macro will work by just pressing a button in the 'Calculations' tab of the model.

Last step, is to calculate the leverage of the project, dividing the total debt by the investment required to build the photovoltaic power plant.

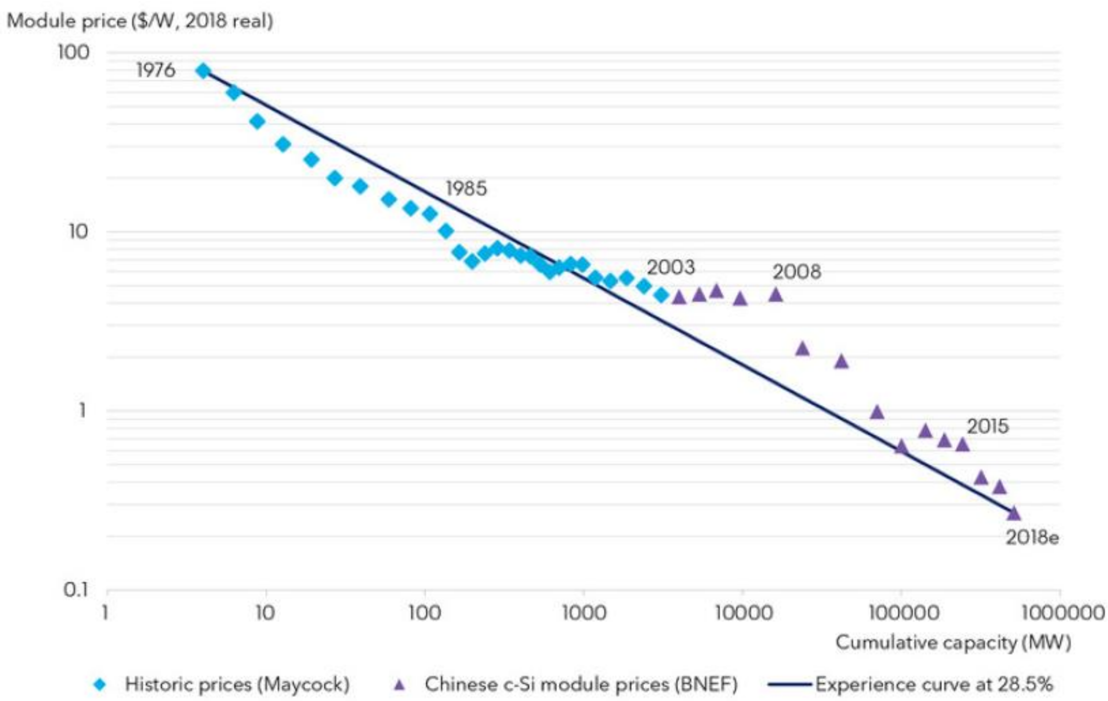
5.2. Inputs of the model

This section is to describe the inputs introduced in the model, that are used to calculate the outputs of the model. The values of these terms are as close as possible to reality, but in some cases, they might not be totally real.

5.2.1. Initial Investment

The initial investment, also called total uses, is one of the most important inputs of the model, as it represents the total amount of money that needs to be paid before the construction of the PV power plant starts. This investment is composed of several terms:

- Solar panels: the costs of crystalline silicon PV modules have been decreasing drastically since 1976 that they were at 79 €/W to 0,37 €/W in 2017. Nowadays these costs are around 0,22 €/W.



Source: BloombergNEO, 2018
Figure 16. PV modules cost

Therefore, the input in the model will be 220.000 €/MWp. As the power plant will be of 8 MWp, the total costs of the solar panels are:

$$Solar\ panel\ costs = 8MWp * 220.000 \frac{€}{MWp} = 1.760.000\ € \qquad (12)$$

- <u>Civil works:</u> this represents the cost of the solar tracker. A single-axis solar tracker nowadays is about 50.000 € per MWp. Therefore:

$$Civil\ works = 8\ MWp * 50.000 \frac{€}{MWp} = 400.000\ € \qquad (13)$$

- <u>Electrical works:</u> this concept corresponds all the electric installations, included the inverters needed to transform the voltage (so the electricity can be introduced in the network) as well as other electrical installations such as all the cables and control devices. The price of inverters is of 40.000 € per MWp, and the rest of electrical works of 300.000 € per MWp. Therefore:

$$Electrical\ works = 8\ MWp * 340.000 \frac{€}{MWp} = 2.720.000\ € \qquad (14)$$

- <u>Interconnection:</u> as explained in Section 3.2., the electricity produced will be introduced in the electricity network through a line that will go from the power plant to the SET of Santanas, located at 5,26 km from the power plant. The cost of this line is of 100.000 € per km. Therefore, the total cost of the line is:

$$Interconnection = 100.000 \frac{€}{km} * 5{,}26\ km = 526.000\ € \qquad (15)$$

- <u>ICIO:</u> this is the *Impuesto sobre Construcciones, Instalaciones y Obras,* which is a tax over any type of construction that require a licence. In the case of Castilla La Mancha, where the power plant will be located this tax is of 4% over the construction costs (Iberley, 2016).

The sum of all the previous terms will lead to what is called EPC costs (Engineering, Procurement and Construction), that represents the costs that should be paid to an engineering company in order to build the power plant. The total EPC costs are included in Table 2.

Table 2. EPC Costs

Concept	Value
Solar panels	1.760.000 €
Civil works	400.000 €
Electrical works	2.720.000 €
Interconnection	526.000 €
ICIO	216.240 €
EPC	**5.622.240 €**
EPC per MWP	**703.780 €/MWp**

However, the total uses include other costs apart from the EPC:

- Development expenditure: these are the costs of bringing the project to reality, such as: engineering costs, cost of the contracts with EPC and O & m companies, searching of lands, measurement of hours of Sun, look up for financing, etc. These costs are paid by the developer company and are estimated at 25.000€/MWp. Therefore, the total development costs are:

$$Development\ costs = 8MWp * 25.000 \frac{€}{MWp} = 200.000\ € \quad (16)$$

Last concept to calculate the total investment needed is the Debt Service Reserve Account (DSRA). This account will be further developed in section 5.3.1. but is basically an account to have reserves in order to pay the debt service. This account needs to have some money before the operation of the power plant starts, and in this case the quantity considered will be:

$$DSRA_0 = 100.000\ € \tag{17}$$

Finally, the total investment needed to construct the power plant is shown in Table 3.

Table 3. Total Uses

Concept	**Value**
EPC	5.622.240 €
Development Costs	200.000 €
DSRA	100.000 €
Total Uses	**5.922.240 €**
Total Uses per MWP	**740.280 €/MWp**

5.2.2. Operation & Maintenance Costs

Every power plant has some cost just for being operated. These are the operations and maintenance (O & M) costs or expenditures (Opex). These costs are composed of several concepts:

- Solar panels maintenance (PV): these Opex represent the maintenance and possible reparations of the solar panels. Currently, these costs are at an annual value of 7.000 € per MWp per year. Therefore, the annual costs are:

$$PV\ O\ \&\ M = 8\ MWp * 7.000\frac{€}{MWp} = 56.000\ € \quad (18)$$

- Balance of plant (BOP): these Opex represent the maintenance and possible reparations of everything except the solar panels. Currently, these costs are at an annual value of 1.000 € per MWp per year. Therefore, the annual costs are:

$$BP\ O\ \&\ M = 8\ MWp * 1.000\frac{€}{MWp} = 8.000\ € \quad (19)$$

- Land lease: this is the cost of leasing a property so the power plant can be built and operated. In this case, this is the money my family will perceive if this project become reality as they are the owners of the land. Currently, the land for renewable power plants is at 1.000 € per hectare per year. This value can seem very low but renting a property por a power plant is a secure investment for 30 years, and the number of landlords willing to rent their property is high. As explained in Section 3.2., the powerplant will occupy an extension of 16 hectares, so the annual costs to the sponsor company are:

$$Land\ lease = 16\ ha * 1.000\frac{€}{ha} = 16.000\ € \quad (20)$$

- <u>Capacity Access Tolls:</u> these are the tolls each producer should pay for the fact of having capacity connected to the electricity network. There are two payments to be done (BOE, 2018): one part to the operator of the market OMIE, and the other to the operator of the system REE (*Red Eléctrica de España,* REE).

  The part paid to OMIE is of 9,37 €/MWp per month, being the capacity the one of the power plants multiplied by a factor of 11 % for PV power plants (BOE, 2018).

$$Capacity\ Access\ Toll\ for\ OMIE = 0{,}11 * 9{,}37 \frac{€}{MWp} = 1{,}0307 \frac{€}{MWp} \tag{21}$$

  The part paid to REE is of 39,82 €/MWp per month, being the capacity the one of the power plants multiplied by a factor of 11 % for PV power plants (BOE, 2018).

$$Capacity\ Access\ Toll\ for\ REE = 0{,}11 * 39{,}82 \frac{€}{MWp} = 4{,}3802 \frac{€}{MWp} \tag{22}$$

  Therefore, the annual amount of the capacity access tolls is:

$$Capacity\ Access\ Tolls = 5{,}41 \frac{€}{MWp} * 8\ MWp * 12\ months = 519{,}36\ € \tag{23}$$

- <u>Energy Access Tolls:</u> these tolls are paid for the fact of injecting electricity in the network. This value depends on the electricity introduced, as it is 0,5 € per MWh injected (BOE, 2011).

- <u>Generation Tax:</u> this is a tax imposed by the Government that is 7 % of the revenues obtained in the electricity market. This tax is paid 50 days after that revenues are obtained, so it will appear as a receivable. This is important in order to calculate the increase of WC, needed for calculating the CFADS.

Therefore, the annual O & M costs will depend on the energy produced. However, supposing 2.279 hours of Sun (see Section 3.2.), the annual Opex are shown in Table 4.

Table 4. Total Annual Opex

Concept	Value
O & M PV	56.000 €
O & M BOP	8.000 €
Land lease	16.000 €
Capacity Access Tolls	519,36 €
Energy Access Tolls	9.116 €
Generation Tax	53.590 €
Annual Opex	**143.230 €**

5.2.3. Net equivalent hours of Sun

The hours of Sun that a certain PV powerplant is going to have is difficult to measure. There are energy companies that do so, or there are public estimations.

The estimation of this thesis is the one approach in Section 3.2. that according to the location of the power plant, it suggests is going to have 2.279 net equivalent hours of Sun per year.

However, these are the hours that are going to happen with a probability of 50 %. However, for debt sizing, banks want to have the less risk possible, so the probability of having certain hours of Sun is 90 %.

The hours of Sun do not have a high volatility, as every year there are the same hours of Sun in each place. Therefore, the hours of Sun that will occur with a 90 % of probability, are 96 % of the hours of Sun that will occur with a 50 % of probability. The P75, will be an average between the P50 and the P90.

The Table 5 shows the number of hours per year according to the probability of them to occur.

Table 5. Net equivalent hours of Sun per year

Concept	NEEH
P50	2.279
P75	2.233
P90	2.188

5.2.4. Pool price forecast

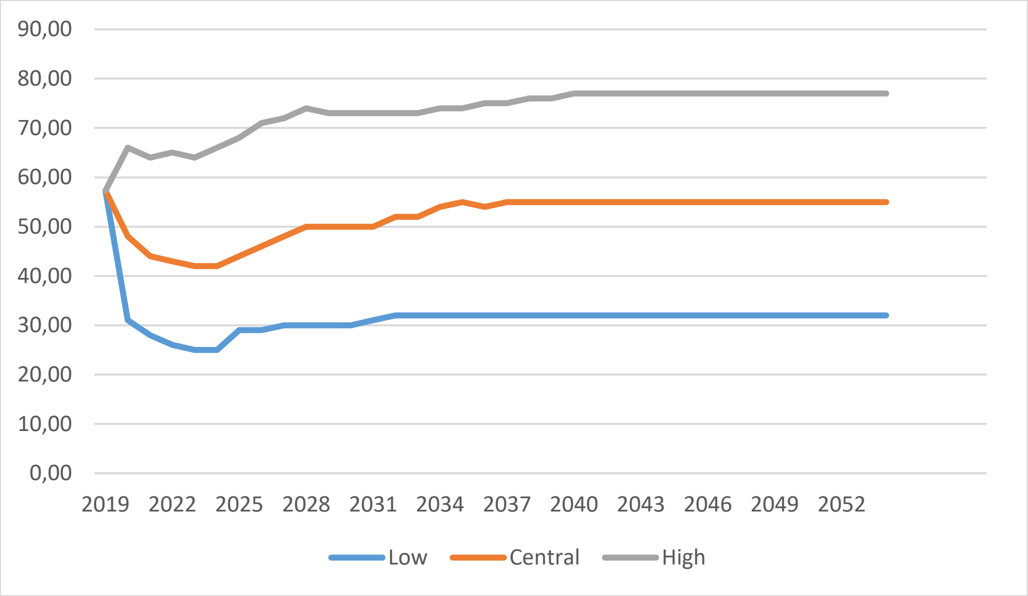
As well as the capture rate, the levels of the pool price in the future is a difficult concept to forecast. Much more difficult is, if the forecast must be done for the next 30 years. Some consultancy firms do these forecasts which are very expensive and are constantly changing their values.

In this master's thesis the prices have been chosen through a market analysis, and including three scenarios: low, central and high, that go from pessimistic to optimistic.

The average price during 2018 was of 57,29 €/MWh (OMIE, 2018b). Taking this price as a starting point, the three scenarios go as follow:

- <u>Low scenario:</u> low level of prices due to the decarbonisation of the economy and the high penetration of renewable energy powerplants. It stabilizes at 32 €/MWh, as bellow that levels of prices the investment in renewables will never be recovered. Therefore, Governments would not let prices fell that much.
- <u>Central scenario:</u> following the levels of prices of the last years, with a decrease at the beginning due to high penetration of renewables, but with a subsequent increase up to today levels (55 €/MWh) due to an increase of demand that the renewables cannot handle alone.
- <u>High scenario:</u> this scenario has a low probability to take place. Supposing the prices of commodities, such as gas or oil, increase a lot, adverse climate situations become more frequent, the demand increases fast or the penetration of renewables is not as expected, prices could increase up to a level of 77 €/MWh.

In Figure 17, the three curves of the pool price forecast can be seen for the next 35 years.



Source: Compilation based on market consensus

Figure 17. Pool Price Forecast 2019 - 2054

5.2.5. Financing Assumptions

In order to do the debt sizing explained in the Section 5.1., some financing assumptions are needed. These assumptions are the ones used in most of the financing of projects through a project finance point of view:

- Debt Service Coverage Ratio (DSCR): this is the most common ratio used in project finance. As explained in section 5.1. it represents the ratio between the CFADS and the debt service.

$$DSCR = \frac{CFADS}{Debt\ service} \quad (24)$$

  The value used in this project is:

$$DSCR = 1{,}05\ x \quad (25)$$

  This is a typical value of this kind of projects. This value is for sizing the debt, but in every period, it will have different values, according to the scenarios chosen of pool price and hours of production.

- Production scenario: banks always want the debt sizing to be calculated with the most pessimistic scenario possible, which is P90.
- Pool price scenario: as it happens with the production scenario, the most pessimistic scenario is needed, which is the Low scenario.
- Period of debt repayment: in project finance, a typical period for repaying the debt is 16 years. Each debt service will be paid every 6 months (in December and in June).
- Interest rate: a typical interest rate for such a big and long debt is 2 % of interest rate of the outstanding debt per period.
- Target DSCR for Lock – Up Account: this concept will be further explained in section 5.3.1., but the Lock-Up Account holds cash if the DSCR of a certain period is lower than the target, which a typical value of it is:

$$Tarrget\ DSCR\ for\ Lock - Up = 1{,}15\ x \tag{26}$$

5.3. Outputs of the model

This section defines the main outputs of the model. First section is to define the cash flow waterfall, that establishes the order in which the costs need to be paid. The two next sections (profitability and leverage) will define the attractiveness of the project and the results are the ones that will be carefully analysed in order to make conclusions on how the capture rate variations affect these results.

5.3.1. Cash Flow Waterfall

The cash flow waterfall is one of the fundamental contracts in project finance (Esty, 2003), which prioritizes claims on cash flows and allocates cash flows accordingly. This contract must be agreed between all the parts involved in the project.

For this master's thesis the main parts consider are: all the counterparts responsible of the O & M of the power plant (such as the network operator Red Eléctrica de España, or the owner of the land that is my family), the market operator OMIE, the bank that lends the money, and the developer (the company that will pay for the equity).

Table 6. Cash Flow Waterfall

Revenues (Total O&M)
EBITDA (Increase)/Decrease in Working Capital (Taxes)
Cash Flow Available for Debt Service (Interest) (Principal)
Cash Flow Available for DSRA (Increase)/Decrease in DSRA
Cash Flow Available for AMA Cost (Asset Management Agreement Cost)
Cash Flow Available for Cash Sweep (Cash Sweep total amount)
Cash Flow Available for Lock-up (Increase)/Decrease in Senior Debt Lock-up Account
FCF

The cash flow waterfall considered for this master's thesis can be seen in Table 6 and is one of the most standard waterfalls used in project finance. After receiving the revenues from the electricity sold at the market, this is the seniority in which these revenues will be used to pay all the costs incurred in the project:

1. O & M: this are all the cost explained in the section 5.2.2. and represent the correct operation and maintenance of the power plant. These are the costs with the highest seniority, as if they are not paid, the project cannot work.

2. Taxes: second level of seniority is the taxes, that are paid to the Government and there are of two types: corporate tax represent a 20% of the EBITDA, and the generation tax already explained, representing 7 % of the market revenues.

3. Senior Debt: once the O & M costs and the taxes are paid, next concept with more seniority is the senior debt, composed by the return of the money lend by the bank and the interests applied to the loan. Not paying the senior debt will make the project enter in the state of default, that could lead to the bank owning the power plant. That is why it has a high level of seniority in the cash flow waterfall, and as it going to be seen next, there are two extra accounts created to be secured that the senior debt is paid.

4. Debt Service Reserve Account (DSRA): this account is paid to the same bank that lends the senior loan. This account serves as a way of securing that the senior debt is paid. If some period the senior debt cannot be paid with the CFADS, the DSRA will pay for it. The way of calculating how much money this account needs to have, is so that every period it must have the debt service of the next period.

$$DSRA_n = Debt\ Service_{n+1} \tag{27}$$

Furthermore,

5. Asset Management Agreement Cost: the energy and infrastructure project are normally managed by asset management companies, which are normally bellow the senior banks in seniority.

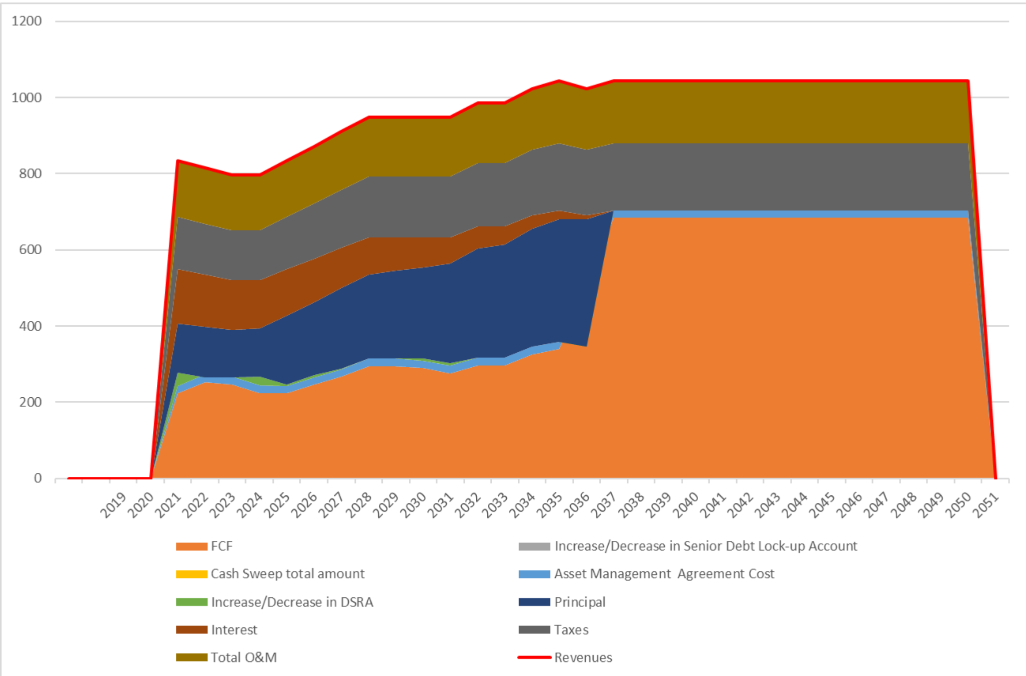
6. Cash Sweep: when a certain project is having a positive outcome, sometimes there is a cash sweep. This means that a certain point, a great part of the outstanding debt is paid. For example, paying 50 % of the outstanding debt at year 10. This sweep has the advantage of reducing the amount of interests paid in the following periods. However, in this master's thesis there is no cash sweep considered.

7. Lock – up Account: this account, as happened with the DSRA, is made to be sure that the debt service is paid. The amount of money this account needs to have is calculated comparing the DSCR at every period with a target DSCR. In this case:

$$Target\ DSCR\ Lock-Up = 1{,}15\ x \quad (28)$$

If in a certain period the real DSCR (of that period and of the next period) is less than the target DSCR (1,15 x in this case), then all the cash flow available for lock-up account will be allocated in that account.

8. Equity: when all the above is paid, the remaining cash is the free cash flow (FCF), which goes to the parts that invested the equity of the project company. It can happen, that in some periods the FCF is negative. However, this does not mean that the equity must invest more money, but with the cash earned in the previous periods is enough (at least in this case).



Source: Prepared by the author

Figure 18. Example of the cash flow waterfall

A good graphical example of the cash flow waterfall is shown in Figure 18. As it can be seen in such figure, the revenues are used to pay all the expenses.

The first thing to look at is the order of precedence explain before, in which the Opex are paid first, then the taxes, then the debt service, then the

DSRA, then the AMA Costs, then the Cash sweep and finally the lock-up account. The remaining amount of money goes to the equity investors as free cash flow.

It is interesting to look at the debt service frame (Principal + Interest). The interests are paid based on the outstanding debt. So, these interests are reduced, whereas the principal paid is increased, so the debt service paid is a quantity that is similar in each period.

Another interesting and logic frame to look at is the FCF. During the debt service period this free cash flow is not very high, but when all the debt is paid, it increases drastically. Therefore, project finance is an interesting tool as the high levels of leverage provide makes, that the debt service is also high. But when the debt is paid the levels of FCF are a big stake of the revenues, making high profitability projects.

5.3.2. Internal rates of return: project and equity

This section is to explain how to calculate the profitability of the project. The concept used is the Internal Rate of Return (IRR), that gives the profitability of a certain project.

The IRR can also be described as the discount rate that makes the Net Present Value (NPV) zero. The NPV it is a tool to calculate the value of cash flows that take place in different moments.

Being ‘r’ the discount rate, ‘CF’ the cash flow generated in every period of the investment and ‘n’ the number of periods, the NPV is calculated as shown in the next formula:

$$NPV = -Investment + \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} \quad (29)$$

Therefore, the IRR is:

$$0 = -Investment + \frac{CF_1}{1+IRR} + \frac{CF_2}{(1+IRR)^2} + \cdots + \frac{CF_n}{(1+IRR)^n} \quad (30)$$

As can be seen, this is a differential equation that might be solved using a software programme. Excel as part of its library has the function ‘IRR’ that calculates the IRR of certain cash flows.

Having the concept of IRR clear, it is important to distinguish between two types of IRR: the project and the equity one.

- <u>Project IRR:</u> it is a metric of the project profitability. Therefore, it takes as initial investment the total uses of the project, and every cash flow is the one that the project itself generate, this is the CFADS.

$$0 = -Total\ Uses + \frac{CFADS_1}{1+IRR} + \frac{CFADS_2}{(1+IRR)^2} + \cdots + \frac{CFADS_n}{(1+IRR)^n} \quad (31)$$

- <u>Equity IRR:</u> it is a metric of the profitability that the equity investors will get for investing in the project. Therefore, the initial investment is the equity invested (Uses-Debt) and the cash flows are the free cash flow that is the money that the investors get in return for their investment (lowest part of the cash flow waterfall).

$$0 = -Equity + \frac{FCF_1}{1 + IRR} + \frac{FCF_2}{(1 + IRR)^2} + \cdots + \frac{FCF_n}{(1 + IRR)^n} \quad (32)$$

This two IRR is the first metrics investors take a look at to decide if a certain investment is good or not. Therefore, they will be analysed in the results section to see how the capture rate variation affects them.

5.3.3. Financial leverage

Financial leverage is the other most important metric in order to decide to invest or not in a certain project. It is especially important for investor that do not have financial strength, as the leverage represent the part of the total uses that the bank will pay. A low leverage means that the sponsor company will have to pay a high quantity of equity.

The financial leverage is the ratio between the debt the bank will pay for the project and the total uses of it.

$$Financial\ Leverage = \frac{Debt\ [€]}{Total\ Uses\ [€]}\ [\%] \quad (33)$$

The total debt will depend of the scenario chosen, as the CFADS will be different from each.

However, the total uses will always be the same. As explained in section 5.2.1. these uses are of 5.922.240 €. Therefore:

$$Financial\ Leverage = \frac{Debt\ [€]}{5.922.240\ €}\ [\%] \quad (34)$$

6. Results

After the model have been explained, it is time to expose the results of the model.

The objective of this thesis was to demonstrate how the capture rate could affect in a negative way the profitability and leverage in the financing of a photovoltaic power plant.

The way of doing it was by running a sensitivity analysis with all the capture rate scenarios presented in Section 4.

For doing this sensitivity analysis, a scenario of price and net equivalent hours of Sun was chosen, being the same for all the capture rates, for having the most objectives results possible. This is the sponsor scenario, as for everyone, except the banks, is the scenario that will be shown for financing.

So, the scenario chosen for pool price is the Central Scenario because is the most standard one. And for hours of Sun, the scenario chosen was the P50.

Table 7. Sponsor Scenario for running the sencitivity analysis

Concept	Scenario
Pool Price	Central
Net Equivalent Hours of Sun	P50

Therefore, the results for each of the captures rates scenarios are presented hereafter. The numeric results are presented in Annex A.

6.1. Low Scenario

This is the most pessimistic scenario, in which the capture rate levels are reduced from 104 % to 43 % by 2040 linearly.

For this scenario, the total debt achieved for financing the project is of 2,49 million € (equity of 3,4 million €). Therefore, the financial leverage is of:

$$Financial\ Leverage = \frac{2.493.797}{5.922.240} = 42{,}11\ \% \quad (35)$$

This leverage is very low for a project finance structure as normal levels go from 55 % to 70 %.

Regarding the profitability, the IRRs obtained are shown in the table below:

Table 8. Project and Equity IRR for the Low capture rate scenario

IRR	Value
Project	4,58 %
Equity	4,88 %

These levels of return are very low, and investors will not be willing to put equity in this project as the risk is higher than other investments with the same return such as public bonds.

Figure 19 shows the cash flow waterfall in a graphic way for each of the years. As can be seen in the figure, the revenues keep reducing due to the reduction of the capture rate. This makes that when the whole debt is paid in 2037, the free cash flow (what the equity investors get) does not grow much. This is the reason why the equity IRR is so low.

As for the project IRR, it is necessary to look at the CFADS (Revenues – O&M - Taxes). It starts at 500.000 € and decreases to almost 200.000€. Considering that the investment to be recovered is of almost 6 million €, the project IRR is very low, as it will take more than 15 years to recover the investment.

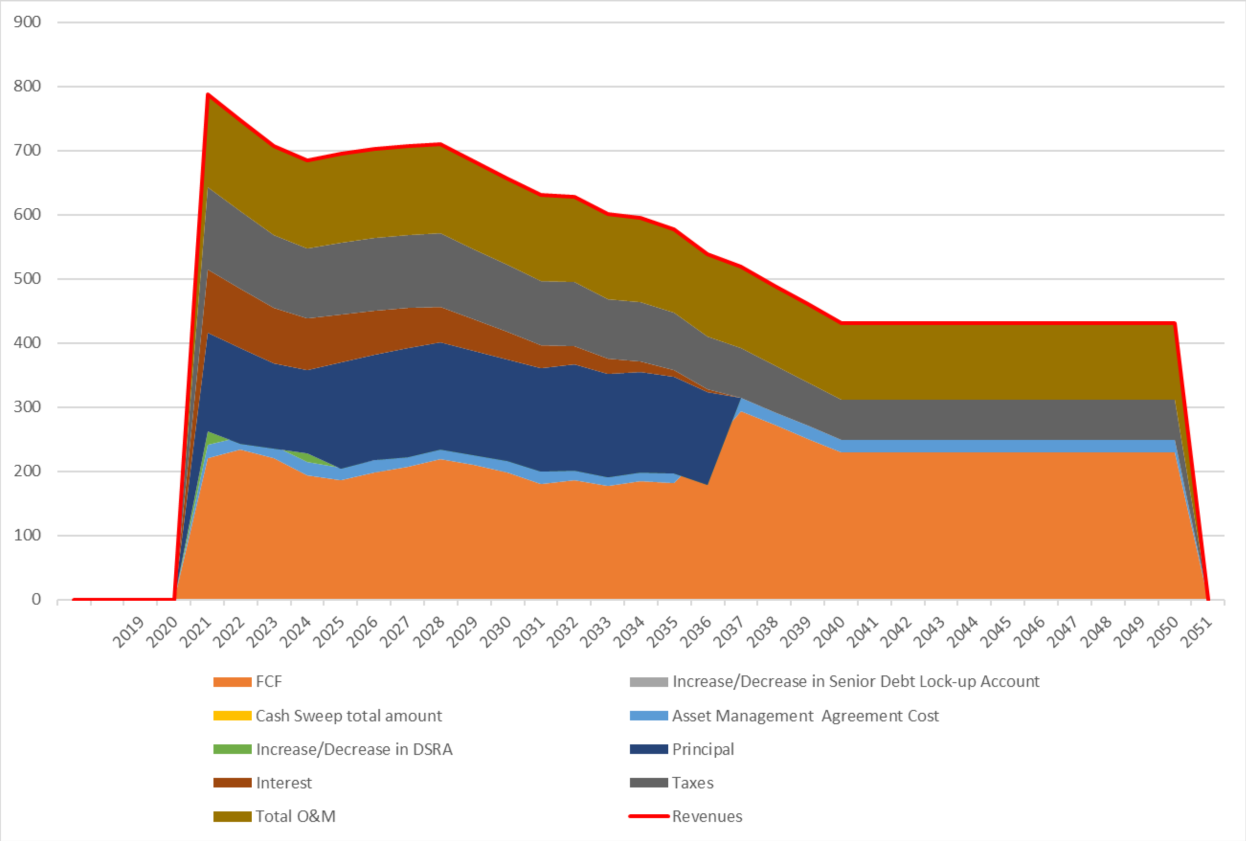


Figure 19. Cash flow waterfall for the Low capture rate scenario

Despite being the worst scenario possible, the project will be viable, as the debt is repaid in every period, and there is free cash flow available for equity investors. It is not a good investment, but with incentives from the Government there will be players willing to take the risks.

However, it must be reminded that this analysis was done with the Central scenario of prices and P50 of production. If the Low prices scenario was chosen, there is not FCF during the debt service period and the IRRs take negative values, meaning the investment is never recovered.

6.2. Central Scenario

This scenario was more optimistic than the previous one. In it, the capture rate reduces from 104 % to 65 % by 2040 in a linear way.

As expected, the debt achieved with the banks is higher than in the previous case, being of 2,9 million € (equity of 3 million €). Therefore, the financial leverage is:

$$Financial\ Leverage = \frac{2.890.273}{5.922.240} = 48{,}80\ \% \qquad (36)$$

This leverage is closer to the expected levels of a project finance structure, but still is not that attractive for investors.

As for the IRR, the results are shown in Table 9. This are more attractive IRRs, but still equity investors of renewable energy projects look for higher returns.

Table 9. Project and Equity IRR for the Central capture rate scenario

IRR	Value
Project	6,50 %
Equity	7,97 %

The cash flow waterfall is shown in Figure 20. As shown in there, the free cash flow increases more than in the previous case, once the debt service is paid, making the equity IRR increase. However, the CFADS is still low as it remains close to 500.000 €, so the total investment will take around 12 years to be recovered.

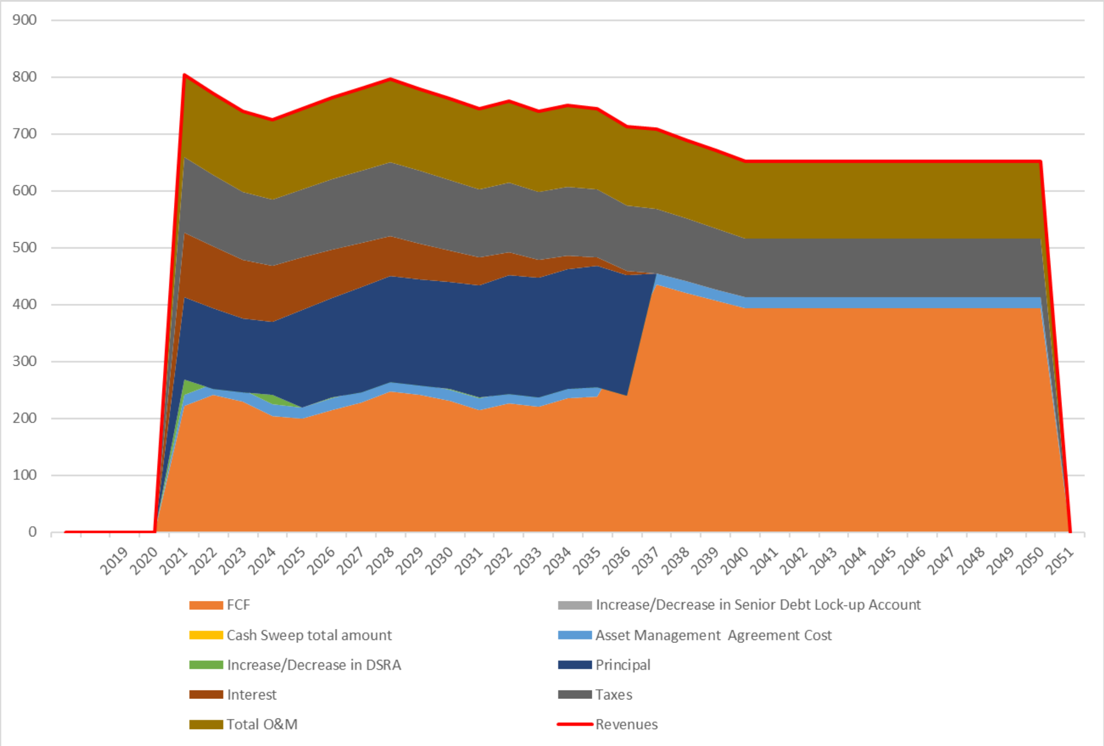


Figure 20. Cash flow waterfall for the Central capture rate scenario

Despite being a better scenario than the previous, it still does not reach leverage of 50 %, and the IRRs are not attractive. Furthermore, regarding the Altran report, this scenario has a higher probability of occurring, as it considers the installation of just 10 GW of photovoltaic energy.

As in the previous case it is important to remind that the pool price forecast is in the Central scenario. If it was in the Low one, there will not be any free cash flow until the debt service is totally paid, and both IRRs will also be negative, meaning the investment is never recovered by the project nor the equity.

6.3. High Scenario

This is the most optimistic scenario of the ones that suppose that the capture rate will be reduced in the future. It supposes that the capture rate decreases linearly from 104 % to 90 % by 2040.

The debt achieved by this scenario is of 3,3 million € (equity of 2,58 million €). Therefore, the financial leverage is of:

$$Financial\ Leverage = \frac{3.341.438}{5.922.240} = 56{,}42\ \% \tag{37}$$

These levels of leverage are much more acceptable than the previous ones, as more than half of the initial investment is paid with a loan from a bank, making the project finance tool a good resource.

Regarding, the IRRs of the project and equity, they take a much more attractive value. Specially, the equity case has an IRR above 10 % which is a value attractive to investors.

Table 10. Project and Equity IRR for the High capture rate scenario

IRR	Value
Project	8,16 %
Equity	11,18 %

Regarding the cash flow waterfall, this can be seen in Figure 21. First thing to look at is the free cash flow, as now it reaches the 500.000 € when the debt service period finishes, what makes the equity IRR more than 3% higher than in the previous case. Regarding the CFADS it start at almost 500.000 € per year and reaches the 600.000 €, what makes the total investment recovered in 10 years approximately, making the project IRR 2% higher than in the previous case.

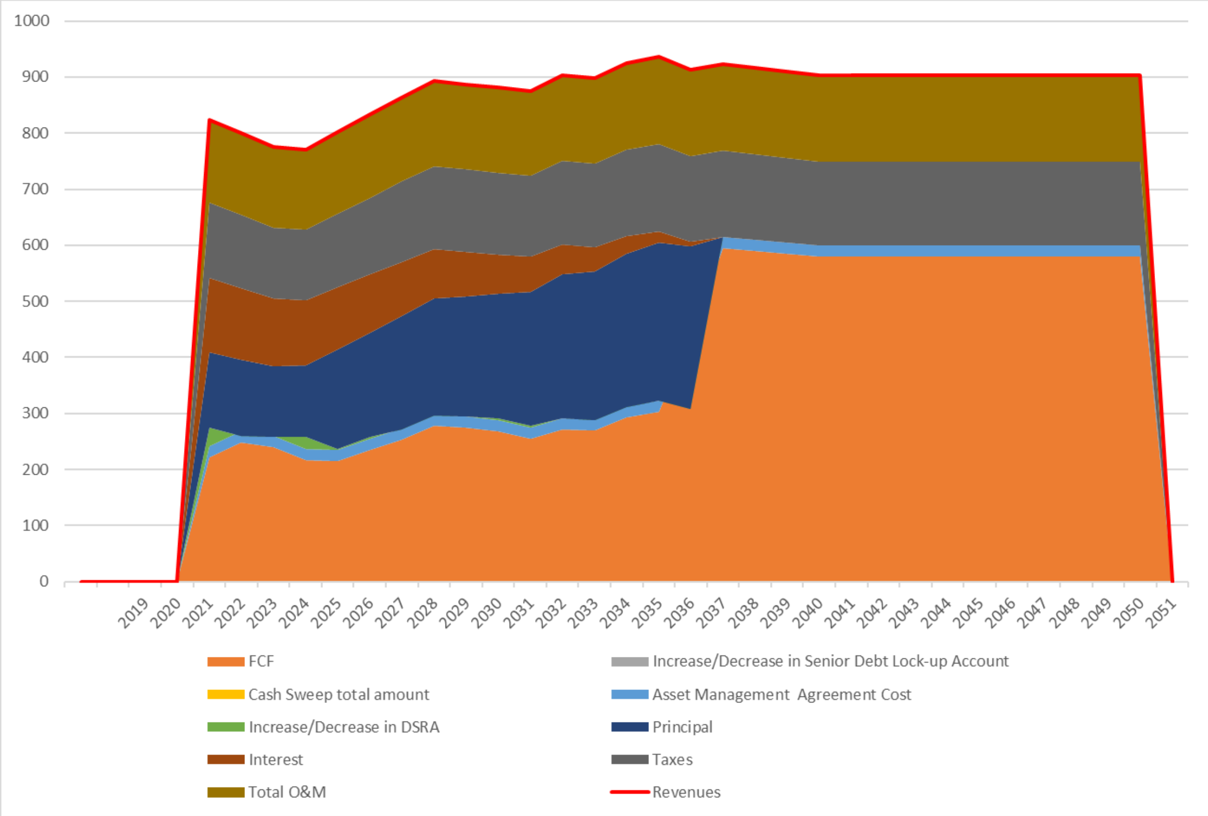


Figure 21. Cash flow waterfall for the High capture rate scenario

This scenario is more attractive than the previous one and will attract investors to the photovoltaic energy market.

If the pool price scenario was the Low one, there will not be FCF during the debt service period, but both project and equity IRRs will be above one (3,21 % and 2,19%) meaning that the investment would still be recovered.

6.4. Flat 100 % Scenario

This is a scenario that supposes that the capture rate remains at 100 % during the whole operating life of the project. In other words, it is like the energy was sold at exactly the average pool price.

The debt achieved by this scenario is of 3,4 million € (equity of 2,5 million €). Therefore, the financial leverage is:

$$Financial\ Leverage = \frac{3.425.018}{5.922.240} = 57{,}83\ \% \qquad (38)$$

This leverage is a little bit higher than in the previous case, being attractive to sponsor companies in order to develop their projects.

The project and equity IRRs can be seen in Table 11. This IRRs are like the ones of the High capture rate scenario, being values in which investors would feel comfortable.

Table 11. Project and Equity IRR for the Flat 100 % capture rate scenario

IRR	Value
Project	8,53 %
Equity	11,90 %

The cash flow waterfall is shown in Figure 22, being very similar to the previous case. What deserves a mention is that the free cash flow achieves values beyond the 600.000 € per year what reduces the return period of the equity investment. Regarding the CFADS, it is similar to the previous case, making the return period if the total investment in around 10 years.

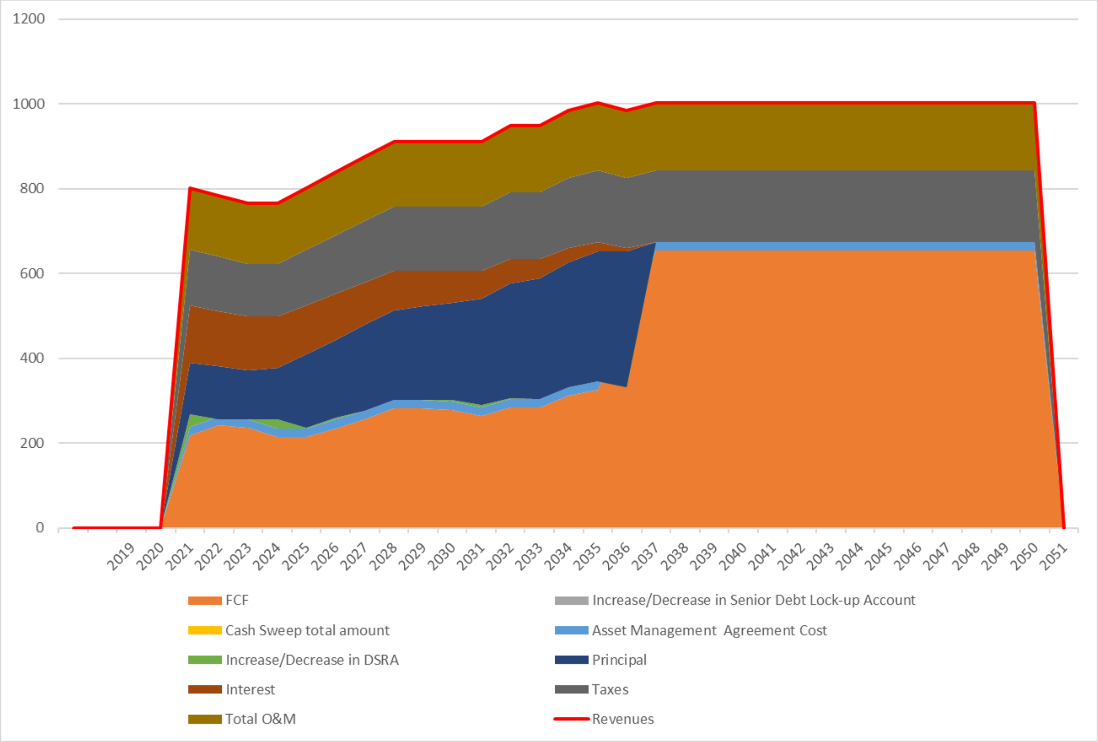


Figure 22. Cash flow waterfall for the Flat 100 % capture rate scenario

6.5. Current 104 % Scenario

Last scenario considered is the one that currently most of the investors use in order to do their project finance projections. It considers the capture rate remains at 104 % during the whole operating life of the power plant. This is because currently the electricity generated at PV power plants is sold 104 % times higher than the average pool price.

With this scenario, the debt achieved is of 3,6 million € (equity of 2,3 million €), making a financial leverage of:

$$Financial\ Leverage = \frac{3.593.926}{5.922.240} = 60{,}69\ \% \quad (39)$$

This is the leverage that are currently expecting the investors of the renewable energy market, as it is above 60 %.

Regarding, the IRRs they offer a very attractive and safe investment both for the project as a whole and for the equity part. Having an equity IRR of 13 % is a profitability that is not offered by many investments. Considering the equity represents 2,3 million €, the return period of it will be below the debt service period.

Table 12. Project and Equity IRR for the Current 104 % capture rate scenario

IRR	Value
Project	8,95 %
Equity	13,04 %

The cash flow waterfall, shown in Figure 23 is similar to the previous one, with a the remarkable fact that the annual revenues go beyond 1 million € during the last years of the operating life.

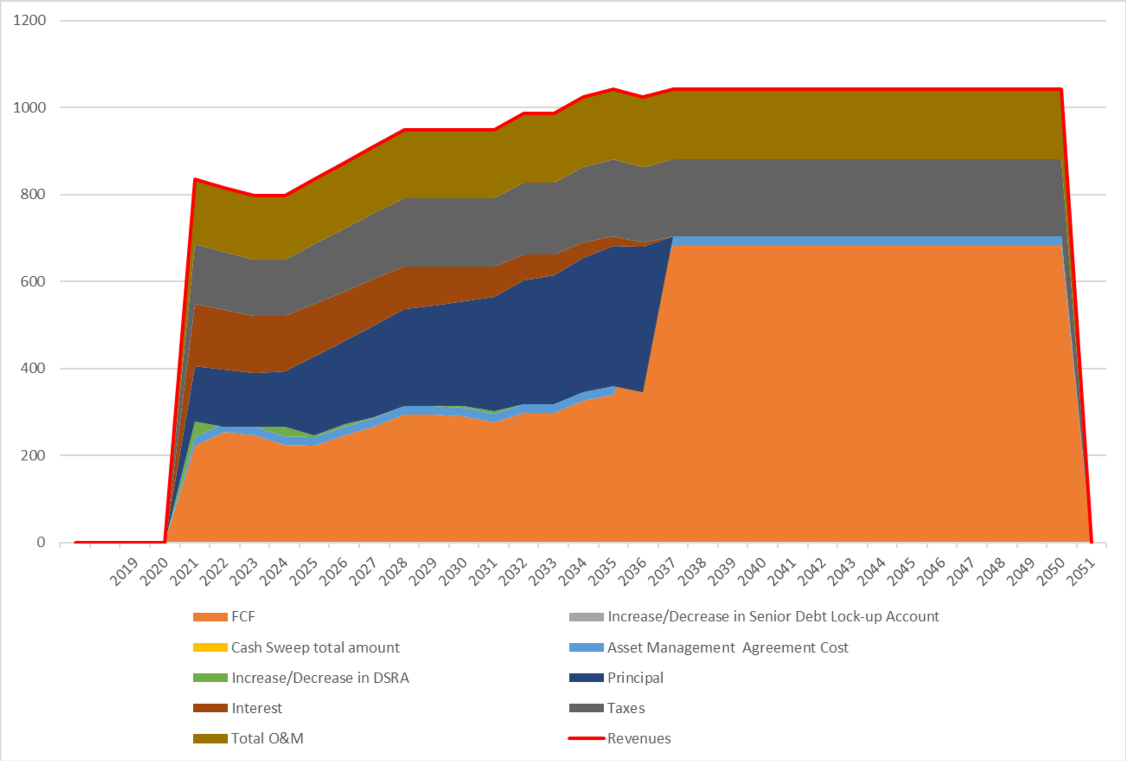


Figure 23. Cash flow waterfall for the Current 104 % capture rate scenario

This capture rate of 104 % in the whole operating life of the project is what investors are using today. However, in one way or another the capture rate may be reduced, so investors should not consider this scenario anymore.

It is also important to remark that choosing the Low prices scenario, happens the same as in the previous cases: there is not available FCF during the debt service period. Furthermore, if this scenario was chosen, the project and equity IRRs will be 4 % and 3,5 % which will not make it an easy investment. Therefore, even if the capture rate remains at a 104 %, a drastic reduction of the level of prices would make the investment in PV power plants unprofitable.

6.6. Summary of the results

Based on all the results above it is time to recapitulate all the results obtained for each of the capture rate scenarios. These results are gathered in Table 13.

Table 13. Summary of the results obtained

Capture Rate	Debt [€k]	Financ. Leverage	Project IRR	Equity [€k]	Equity IRR
Low	2.494	42,11%	4,58%	3.428	4,88%
Central	2.890	48,80%	6,50%	3.032	7,97%
High	3.341	56,42%	8,16%	2.581	11,18%
Flat 100 %	3.425	57,83%	8,53%	2.497	11,90%
Current 104 %	3.594	60,69%	8,95%	2.328	13,04%

Looking at the financial leverage and the IRRs, it can be said that the capture rate really affects the financing of the project and the profitability of it:

- The financial leverage differs in almost 20 percentual points between the worst and the best scenario of capture rate. This is a really big difference, especially if it considers that this difference could be the critical point of some sponsor companies to decide whether to continue with the investment or leaving it.

- Related with it, the equity necessary varies in more than 1 million € between the two extreme cases.

- The project IRRs differ in more than 4 percentual points between the extreme cases. In the case of low and central scenarios, these IRRs would not be acceptable for banks.

- The equity IRRs differ in more than 8 percentual points, which is a driving factor for this type of investors.

However, it is also important to remark that all the scenarios make the project financially viable. In all of them, the debt assumed is repaid, and the IRRs are acceptable.

The first two scenarios might not be attractive, and in many cases, developers and investors will not be willing to invest. However, the projects will work and with necessary incentives from the government.

Lastly it is important to remark the fact that this analysis have been done with a Central forecast of pool prices. A drastic decrease of prices down to 32 €/MWh (Low prices scenario), makes the investment of a very low profitability, and in many cases (Low and Central capture rate scenarios) the investment is not recovered.

7. Conclusions

The main objective of this master's thesis was to analyse how a variation of the photovoltaic capture rate could affect the financing of a photovoltaic power plant.

For achieving this objective, a photovoltaic power plant in the province of Albacete has been taken as a reference for constructing the financial model. Through a market research, the inputs of the model have been as close to reality as possible, so the model could be not only an adequate model but robust.

There has also been a description of what is the capture rate, and its importance in the financing of any energy projects (especially renewable energy ones in which the energy is produced at specific moments of the day). Then, there has been a description of the factor that could drive the PV capture rate up, and the ones that could bring it down, finishing with the exposition of the five scenarios that were going to serve for the sensitivity analysis.

Finally, after explaining the outputs of the model, and how these are calculated, there has been a final section for the results obtained with the model.

Based on these results and the objective pursued, it has been proven that the variation of the capture rate definitely affects the financing of the photovoltaic power plant, as well as the profitability of the project. The main proof of it, is how the financial leverage differs in almost 20 percentual points between the most pessimistic scenario (42,1 %) and the most optimistic (60,6 %). This variation can be a decision factor when sponsor companies are willing to promote a photovoltaic project. Therefore, the final decision on what capture rate forecast is going to be used for the financing is on the banks, as they will lend the money. Henceforth, having accurate forecasts is a must in order to achieve financing.

The other two factors that demonstrate the big impact the variation of the capture rate has in PV projects are the project and equity IRR. These factors represent the profitability the investment paid will have. For those individuals involved in the equity investment, the equity IRR will be one of the most important factors to enter or not in the investment. So, the worst projection of capture rate suggest that any project sized with them will probably not see the light. So again, the sizing criteria must be believed by the equity investors, so not only the IRR is adequate but true.

As an additional analysis, it has been proven that another factor that affects very negatively the financing of the project is the low pool price forecast. In the case the Spanish pool price decreases to 32 €/MWh or less, regardless the capture rate forecast, these projects will have a very low probability with the current conditions. Having accurate pool prices projections are also important for project finance structures.

If the forecast were the most negative the photovoltaic cannibalization will not occur. However, countries are fighting against climate change, so with the appropriate incentives and green policies, renewable energy would hopefully be an important stake of the Spanish electricity market.

To conclude this master’s thesis, it has been demonstrated the negative impact of the decrease of the capture rate in the future. Therefore, having accurate forecasts are very important for any financial analysis, as they can be the critical factor that determines if the project see the light or not. The final recommendation is that any sponsor company willing to develop a photovoltaic power plant should spend money and effort on their forecasts, so they are as accurate as possible, so banks and equity investors can believe them in order to lend their money.

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A. CASH FLOW WATERFALL

This annex is to show the numeric results of the cash flow waterfall for each scenario of capture rate.

Table 14. Cash flow waterfall for the Low capture rate scenario

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Revenues	-	-	788	747	707	685	694	702	707	710	683	657	630	628	600	595	577	538
Total O&M	-	-	145	142	139	138	138	139	139	139	137	136	134	134	132	131	130	127
Taxes	-	-	129	121	114	110	111	113	114	114	109	104	99	99	94	93	89	82
Interest	-	-	98	92	86	81	76	69	62	55	49	42	36	29	23	17	10	4
Principal	-	-	154	149	133	129	166	165	170	167	163	158	162	166	161	156	151	145
Increase in DSRA	-	-	22	(11)	(5)	14	(2)	(1)	(5)	(5)	(5)	(2)	(1)	(5)	(6)	(6)	(6)	(75)
Asset Management Agreement Cost	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	-	-	221	234	220	194	186	198	206	219	211	198	181	186	177	184	182	234

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Revenues	519	489	460	431	431	431	431	431	431	431	431	431	431	431	-	-	-	-
Total O&M	126	124	122	120	120	120	120	120	120	120	120	120	120	120	-	-	-	-
Taxes	79	73	68	62	62	62	62	62	62	62	62	62	62	62	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in DSRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset Management Agreement Cost	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	-	-	-
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	294	272	251	229	229	229	229	229	229	229	229	229	229	229	-	-	-	-

Table 15. Cash flow waterfall for the Central capture rate scenario

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Revenues	-	-	805	772	739	725	745	763	780	796	779	762	745	757	739	750	745	713
Total O&M	-	-	146	144	141	140	142	143	144	145	144	143	142	143	141	142	142	140
Taxes	-	-	132	126	120	117	121	124	127	130	127	124	121	123	120	122	121	115
Interest	-	-	114	108	103	98	92	85	78	71	63	56	48	40	32	23	15	6
Principal	-	-	144	143	130	128	171	174	185	186	187	188	198	209	210	211	212	213
Increase in DSRA	-	-	27	(10)	(4)	17	(0)	2	(3)	(3)	(3)	1	1	(3)	(4)	(4)	(4)	(110)
Asset Management Agreement Cost	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	-	-	221	241	230	205	199	215	228	247	241	231	215	226	220	235	239	330

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Revenues	708	689	670	652	652	652	652	652	652	652	652	652	652	652	-	-	-	-
Total O&M	139	138	137	135	135	135	135	135	135	135	135	135	135	135	-	-	-	-
Taxes	114	110	107	103	103	103	103	103	103	103	103	103	103	103	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in DSRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset Management Agreement Cost	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	-	-	-
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	435	421	407	393	393	393	393	393	393	393	393	393	393	393	-	-	-	-

Table 16. Cash flow waterfall for the High capture rate scenario

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Revenues	-	-	824	800	776	771	802	833	863	893	887	881	875	904	898	925	936	912
Total O&M	-	-	147	146	144	144	146	148	150	152	152	151	151	153	152	154	155	153
Taxes	-	-	135	131	126	125	131	137	143	148	147	146	145	150	149	154	156	152
Interest	-	-	133	127	122	117	111	104	96	88	80	71	62	52	42	31	20	9
Principal	-	-	134	136	125	128	178	186	202	209	215	221	238	257	266	274	282	291
Increase in DSRA	-	-	32	(8)	(2)	21	2	4	(0)	(1)	(1)	4	5	(1)	(1)	(1)	(1)	(150)
Asset Management Agreement Cost	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	-	-	222	249	240	217	215	235	253	277	275	268	254	272	270	293	303	438

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Revenues	923	916	909	902	902	902	902	902	902	902	902	902	902	902	-	-	-	-
Total O&M	154	154	153	153	153	153	153	153	153	153	153	153	153	153	-	-	-	-
Taxes	154	152	151	150	150	150	150	150	150	150	150	150	150	150	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in DSRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset Management Agreement Cost	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	-	-	-
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	595	590	585	580	580	580	580	580	580	580	580	580	580	580	-	-	-	-

Table 17. Cash flow waterfall for the Flat 100 % capture rate scenario

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Revenues	-	-	802	784	766	766	802	839	875	912	912	912	912	948	948	985	1.003	985
Total O&M	-	-	146	145	143	143	146	148	151	153	153	153	153	156	156	159	160	159
Taxes	-	-	131	128	125	125	131	138	145	152	152	152	152	158	158	165	169	165
Interest	-	-	136	131	126	121	116	109	101	93	85	76	67	56	45	34	22	10
Principal	-	-	122	125	117	121	173	183	202	211	219	228	249	272	283	295	307	319
Increase in DSRA	-	-	29	(7)	(1)	22	3	5	1	-	-	5	6	1	-	-	-	(164)
Asset Management Agreement Cost	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	-	-	219	243	236	214	213	235	255	282	282	277	265	285	285	312	325	477

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Revenues	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	-	-	-	-
Total O&M	160	160	160	160	160	160	160	160	160	160	160	160	160	160	-	-	-	-
Taxes	169	169	169	169	169	169	169	169	169	169	169	169	169	169	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in DSRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset Management Agreement Cost	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	-	-	-
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	654	654	654	654	654	654	654	654	654	654	654	654	654	654	-	-	-	-

Table 18. Cash flow waterfall for the Current 104 % capture rate scenario

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Revenues	-	-	834	815	796	796	834	872	910	948	948	948	948	986	986	1.024	1.043	1.024
Total O&M	-	-	148	147	145	145	148	151	153	156	156	156	156	159	159	161	163	161
Taxes	-	-	137	134	130	130	137	144	151	158	158	158	158	165	165	173	176	173
Interest	-	-	143	137	132	127	122	114	106	98	89	80	70	59	48	36	23	10
Principal	-	-	128	132	123	127	181	192	212	221	230	239	261	285	297	309	322	334
Increase in DSRA	-	-	35	(7)	(1)	23	3	6	1	-	-	6	6	1	-	-	-	(172)
Asset Management Agreement Cost	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	-	-	223	253	246	224	223	246	267	295	295	289	276	297	297	325	339	498

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Revenues	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	1.043	-	-	-	-
Total O&M	163	163	163	163	163	163	163	163	163	163	163	163	163	163	-	-	-	-
Taxes	176	176	176	176	176	176	176	176	176	176	176	176	176	176	-	-	-	-
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in DSRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset Management Agreement Cost	20	20	20	20	20	20	20	20	20	20	20	20	20	20	-	-	-	-
Cash Sweep Total amount	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Increase in Senior Debt Lock-up Account	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCF	684	684	684	684	684	684	684	684	684	684	684	684	684	684	-	-	-	-